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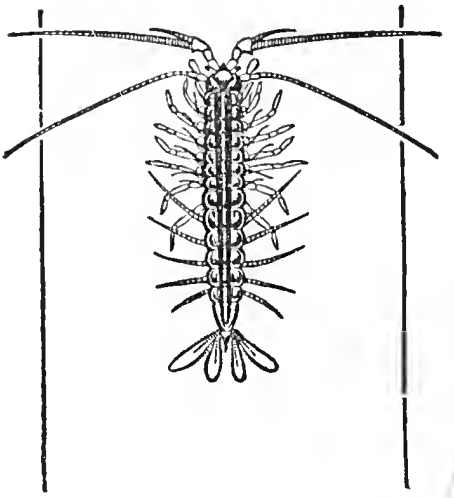

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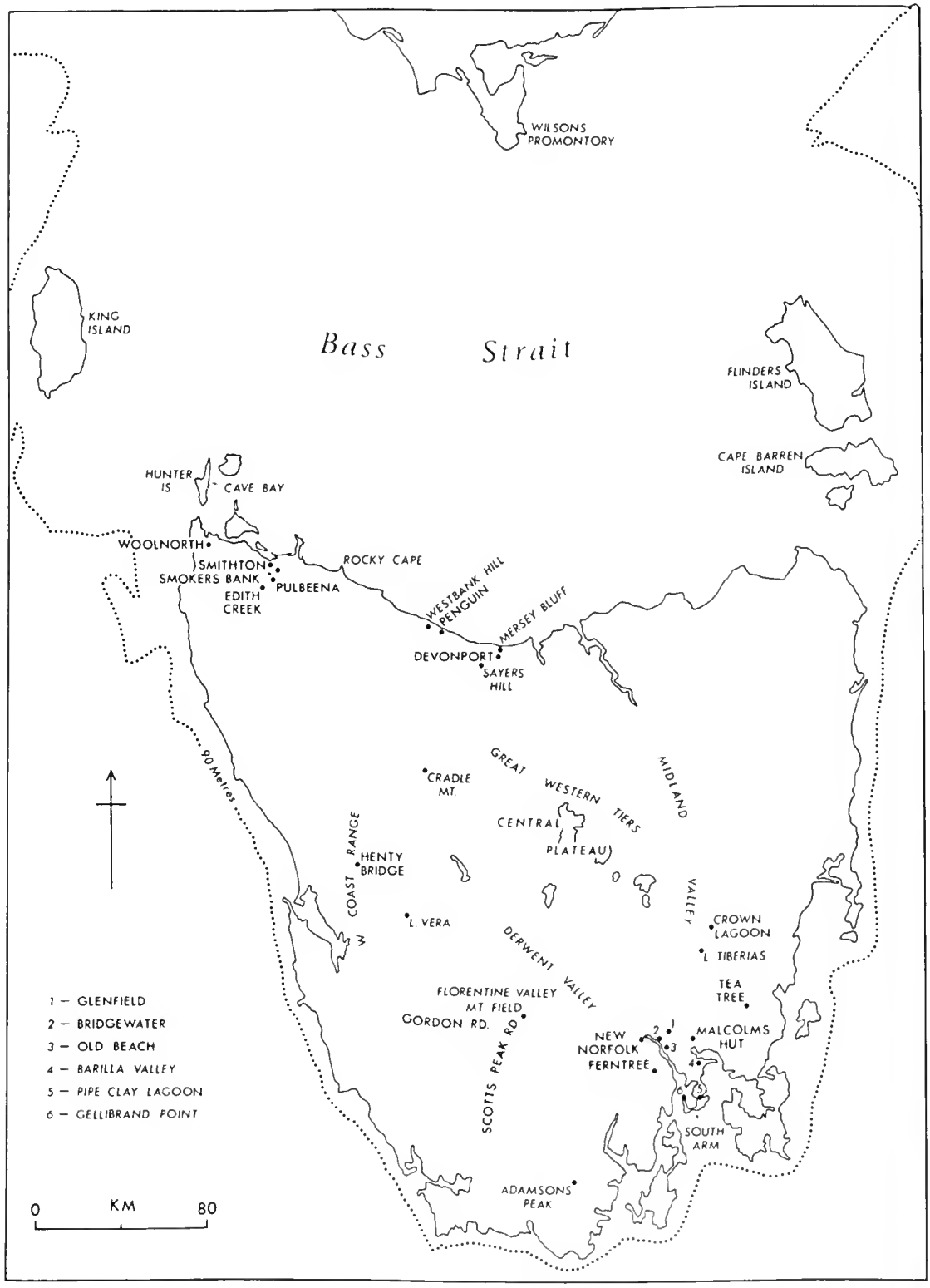

Figure 1. Location of places cited.

THE LATE QUATERNARY ENVIRONMENT OF TASMANIA AS A BACKDROP TO MAN'S OCCUPANCE

by

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ABSTRACT

Three sites which record the presence of Pleistocene age man are now known in Tasmania. A basal ^{14}C date of 22,750 ± 420 BP (ANU-1498) (Bowdler, 1975) for the oldest site shows that aboriginal man arrived in Tasmania prior to the maximum of the Last Glaciation which occurred ∿ 18-20,000 BP. Migrating across the Bass Strait lowlands, which were produced by the glacial lowering of sea level to > 90 m, he entered the cool to cold dry predominantly grassland environment of northwestern Tasmania in which shallow lakes and swamps occurred. There were probably also local areas of open *Eucalyptus* woodlands or *Eucalyptus* savannahs. In the relatively open environment slope mantles were formed and moved downslope by strong frost action during winter, and sandy surfaces were deflated by strong dry winds during summer to produce terrestrial dunes.

The dry areas of southern midland and lowland southeastern Tasmania appear to have been steppe-grasslands between ∿ 20,000 and 10,000 BP, while extensive alpine grasslands and herbfields occurred on the mountains of southwestern Tasmania. The effects of periglacial processes of erosion and deposition produced screes, blockfields, blockstreams, and widespread gelifluction deposits in the uplands, with local occurrences of gelifluction deposits, rhythmically stratified screes and *grèzes litées* on steep slopes in lowland areas. After 12,000-10,000 BP there was major expansion of both sclerophyll and temperate rainforests and a marked reduction in the extent of open environments. Climate became warmer and moister. Geomorphological processes became less effective and slope mantles and sandy surfaces became stabilised. The impact of aboriginal man especially through burning produced local surface instability on slopes and in sandy areas. Localised, yet widespread, aboriginal disturbance of the vegetation and ground surface seems to have contributed to the alluviation of valley floors and remobilisation of surface sands on inhabited dune sites.

INTRODUCTION

Archaeological investigations by Bowdler (1974a, 1974b, 1975) on Hunter Island in northwestern Tasmania demonstrate that aboriginal man migrated across the Bass Plain land bridge during the Pleistocene and had inhabited a cave at Cave Bay on the eastern side of Hunter Island by 22,750 ± 420 BP (ANU-1498) (Figure 1). Geomorphological investigations at Old Beach in the lower Derwent Valley of southeastern Tasmania (Sigleo and Colhoun, 1975) showed that man migrated to the lower Derwent Valley

during the Pleistocene, probably between ~ 20,000 and 10,000 years ago. Goede and Murray (1976) have further extended the range of Pleistocene man in Tasmania by showing that he was present in the Florentine Valley around 12,600 ± 200 BP (R5001/4).

This new evidence for the antiquity of man in Tasmania indicates that he had arrived by the maximum stage of the Last Glaciation and that he crossed the present Bass Strait by dry land when sea level was 90 m or more below present level. This evidence points to the probability of ultimately being able to demonstrate that the occupation by aboriginal man of the present island of Tasmania is almost as ancient as the occupation of adjacent mainland southeastern Australia.

This paper will briefly review some of the biogeographic and geomorphological evidence which informs us of the type of environment into which man migrated and the subsequent major changes which the environment has experienced since his arrival. The evidence comes chiefly from northwestern and southeastern Tasmania.

Aboriginal man migrated southward to Tasmania from southeastern Australia when the climate was much colder than present; during or preceding the maximum stage of the Last Glaciation which has been estimated from ^{14}C dates at Henty Bridge as having occurred at ~ 18-20,000 BP. Between ~ 25,000 and 10,000 BP the Central Plateau, the Cradle Mountain area and the central part of the West Coast Ranges had extensive ice cover and many of the mountain ranges of southwestern Tasmania had cirque and valley glaciers (Davies, 1967; McPhail and Peterson, 1975). These glacial systems were formed and nourished by prevalent moist westerly and south-westerly maritime airstreams at a time when mean annual temperatures have been variously estimated as being 5°C, 6.5°C and 8°C lower than present annual average temperatures which are 10-13°C on low ground decreasing to below 5°C on mountains of over 1,500 m (Davies, 1967; Derbyshire, 1973; Colhoun, 1975). After the maritime airflows had shed most of their moisture on the western mountains and Central Plateau they were adiabatically warmed and dried on descending to the midland valley and broken hilly country of eastern Tasmania. As a consequence during the Last Glaciation, as today, there was a very sharp decrease in precipitation over the eastern part of the Central Plateau and the western part of the midlands. A similar decline in precipitation gradient also occurs northwards from a line connecting Smithton with the Great Western Tiers to the lowland coastal regions of northwestern Tasmania. During the Last Glaciation the gradient of decline was much steeper than it is today. This was due to the increased continentality of the northern lowland regions consequent upon the lowering of sea level which almost doubled the land area of Tasmania. The Bass Strait lowlands also shared this cool to cold relatively dry continental climate which extended from Victoria via northern and midland Tasmania to the lower Derwent Valley where the thin end of Australia's former "Patagonian Wedge" terminated.

NORTHWESTERN TASMANIA

Palynological work is currently in progress on a 470 cm section of late Quaternary lake marl and swamp peat deposits from Pulbeena Swamp, Irishtown (Figure 1) (Colhoun and van de Geer). Lack of any erosional hiatus in the sediment suggests that deposition has probably been continuous as the local conditions fluctuated between lake and swamp conditions over a long period of time. Analysis to date shows that in the upper 215 cm, which represents approximately the last 50,000 years,[1] the dominant elements in the vegetation changed as follows:

[1] Estimates of age are based on ^{14}C dates by Gill and Banks (1956) and Banks, Colhoun and van de Geer (1976) from adjacent sections at Pulbeena and on ^{14}C assays supplied by Groningen University Radiocarbon Laboratory.

Depth 0 - 60 cm Humid Climate	Expansion and dominance of *Eucalyptus* spp. (6-41%) as the regional vegetation, with *Leptospermum* (38-73%) and *Melaleuca* spp. (0-11%) as local damp site components. Occasional pollen grains of long distance transported rainforest species (< 1%). No aquatic element.
∿ 13,000 BP 70 - 150 cm Drier Climate	Expansion and dominance of Gramineae spp. (68-75%), with subsidiary Compositae spp. (3-31%) as the regional vegetation. Rare *Eucalyptus* pollen (0-7%). No rainforest element. A few aquatics present between 120 - 140 cm.
∿ 40,000 BP 160 - 215 cm Humid Climate	Expansion of *Eucalyptus* spp. (8-35%) to co-dominance with Gramineae spp. (7-38%) as the regional vegetation. *Leptospermum* (9-18%), Cyperaceae (16-40%) and Restionaceae spp. (4-25%) abundant as local damp site components. Occasional pollen grains of long distance transported rainforest species (c.1%). Abundant aquatics between 160 - 180 cm.

Figure 1 Section in late Quaternary algal and shell marls with swamp peats at Pulbeena, near Smithton.

The results indicate that at the time of man's first recorded presence (22,750 ± 420 years BP) the regional vegetation of northwestern Tasmania was a grassland with local patches of shrubs and *Eucalyptus* woodland present. After ∿ 13,000 BP there was virtually complete replacement of the grassland by *Eucalyptus* forest on dry sites with *Leptospermum* and *Melaleuca* scrub on damp or swampy sites with high water tables. This major vegetation change is interpreted as having been caused by a change from colder drier glacial conditions to warmer moister postglacial climatic conditions.

There is little other palynological evidence available from northwestern Tasmanian although at Rocky Cape the basal beds of quartzite alluvial fan gravels reveal organic horizons that contain wood and charcoal, and a thin paleosol with roots in growth position (Figure 2).

Figure 2 Alluvial fan gravels at Rocky Cape showing thin organic paleosol to the left of the staff. Wood from the paleosol gave a ^{14}C age of 24,090 ± 1,030 BP (GaK-5155).

^{14}C dates from ~ 32,000 to ~ 24,000 BP have been obtained from this site and pollen spectra show that the regional vegetation consisted mainly of *Eucalyptus*, Gramineae and Compositae spp. At Rocky Cape light *Eucalyptus* woodland or *Eucalyptus* savannah seems to have been the regional vegetation prior to the phase of maximum cold and aridity during the Last Glaciation, and probably prior to or perhaps during the time of man's first arrival.

The lower beds of the alluvial fan were deposited during conditions of intermittent stability/instability in the small catchment, but the upper beds of the fan sequence are devoid of organic materials and accumulated under conditions of general surface instability in the catchment when the local vegetation cover of the steep slopes was markedly reduced. The upper beds of fan gravel were deposited by a stream which was supplied with abundant angular quartzite fragments from mobile slope deposits. These were probably mainly produced by frost shattering of exposed rock surfaces in winter. The ^{14}C dates and local stratigraphy indicate that this phase of major landscape instability post-dates 24,000 BP and pre-dates the Holocene.

There is extensive geomorphological evidence in lowland northwestern Tasmania to demonstrate that during the later part of the Last Glacial Stage soil and regolith mantles were very mobile on steep slopes (> 10-15°), and that where bare rock was exposed strong physical weathering processes produced angular fragmental rubbles of chemically unweathered rock. Under conditions of lowered temperatures, decreased precipitation, and reduced vegetation cover, strong winter freezing of soil and surface moisture would fracture the exposed rock and subsequent thawing would cause the downslope movement of loosened materials by gelifluction processes. Deposits so formed have been found in dolerite, basalt, quartzite and chert areas and include gelifluction deposits, stratified screes and *grèzes litées*. Inversion of old soil profiles and regolith mantles, with the addition of freshly derived angular detritals near the surface, demonstrates the sequential stripping of steep slopes as the cold climatic conditions of the later part of the Last Glacial Stage endured. Stripping of the soil mantle at Sayers Hill in the lower Forth Valley probably commenced before 30,000 BP as indicated by a > 30,600 BP (GaK-5590) assay on charcoal contained in an inverted paleosol which underlies schist and quartzite gelifluction deposits (Colhoun, 1976). Similar inverted soil and regolith sequences are known from Mersey Bluff

near Devonport and Westbank Hill near Penguin when they occur in association with dolerite and quartzite rocks respectively (Figure 3) (Chick and Colhoun, 1972). That widespread instability and movement of materials continued on steep slopes until the commence of the Holocene is supported by a ^{14}C assay of 15,870 ± 820 BP (GaK-5968) on charcoal at 190 cm depth in a stratified slope deposit composed of 0.5 to 3 cm long angular fragments of chert, shale and quartzite at Hardstaff Creek in the Leven Valley.

Figure 3 Quartzite gelifluction deposits at Westbank Hill near Penguin

There is evidence for the formation of terrestrial sand dunes with a predominantly west to east orientation on the Woolnorth Estate of the far northwest. A small area of terrestrial dunes occurs at Edith Creek 14 km south of Smithton, and a shallow lagoon bounded on its eastern margin by a lunette occurs at Smokers Bank 2 km southeast of Smithton (Figure 4) (van de Geer, pers. comm.). These terrestrial dunes and lunette are the most northwesterly known in Tasmania and resemble dunes described from the midland valley and northeastern Tasmania (Nicolls, 1957; Davies, 1967; Bowden, pers. comm.). They are considered to indicate at least seasonally very dry conditions during the later part of the Last Glaciation (Colhoun, 1975).

Although continuity of evidence has yet to be presented, one migration route which could have been followed between northern and southeastern Tasmania during the late Pleistocene would have been via the Midland Valley to the lower Derwent Valley. Biogeographic and geomorphologic evidence has recently become available for the southern part of the midlands and the lower Derwent Valley and allows a partial reconstruction of the paleoecological and paleoclimatic conditions that prevailed during the time of man's first occupance of southeastern Tasmania.

Figure 4 Terrestrial sand dune of late Last Glacial age at Edith Creek.

SOUTHEASTERN AND SOUTHWESTERN TASMANIA

Pollen analysis of thin organic sediments associated with the beginning of a major phase of surface instability and aeolian sand deposition at Pipe Clay Lagoon, South Arm indicates that between 25,420 ± 460 BP and 19,840 ± 280 BP (SUA-151 and SUA-153) there was a reduction in pollen of *Eucalyptus* spp. from 73% to 4% with marked increases in Gramineae (8 to 19-24%), Compositae (3 to 5-11%) and Cyperaceae (2-66%) (Figure 5). The pollen changes probably indicate a change from *Eucalyptus* woodland to more open *Eucalyptus* savannah or grassland, which may have been caused by an increase in the intensity of the colder and drier climatic conditions of the maximum phase of the Last Glacial Stage.

In the southern part of the midlands a 283 cm core from Lake Tiberias has revealed a late Quaternary vegetation sequence of three units (Macphail, pers. comm.).

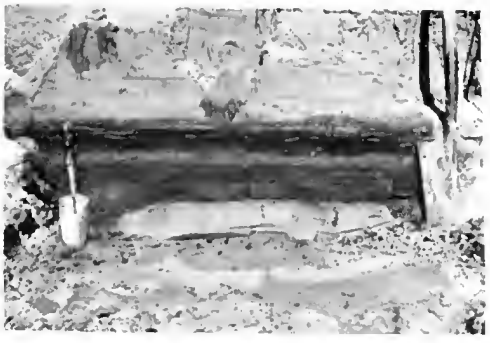

Figure 5 Organic beds overlying marine sands and buried by aeolian sands at Pipe Clay Lagoon. Note the laminated character of the upper organic stratum which accumulated after the commence of aeolian activity.

Unit	Depth	
3	0.205 cm	Dominated by *Eucalyptus* spp. (70-80%) throughout but with significant amounts of *Pomaderris apetala-Spyridium* type pollen above 184 cm and *Casuarina* in the upper third of the unit.
2	210 -250 cm [∿ 215 220 cm] [9550 ± 200 BP (GaK-2239)] [Goede, 1968, unpublished]	Dominated by *Eucalyptus* spp. (30-60%) but characterized by maximal percentages of *Phyllocladus asplenifolius* (38%), *Dicksonia antarctica* (10%), Compositae (5%), with considerable Chenopodiaceae (8-20%).
1		Characterised by Chenopodiaceae (30%) and Gramineae spp. (20%), with *Eucalyptus* spp. (25%) and *Phyllocladus asplenifolius* (15%).

This sequence is interpreted as illustrating the replacement of a sparse steppe-grassland association in late glacial times by a mosaic of *Eucalyptus* dry sclerophyll woodland and *Poa-Eucalyptus* savannah-woodland in the Holocene. These vegetation associations, although influenced by fire and aboriginal burning, are regarded as being ecologically adjusted to the present numerous winter frosts and marked summer drought conditions of the southern midlands. The significant component of *Pomaderris apetala-Spyridium* type pollen is interpreted as indicating moister conditions prior to and during the mid-Holocene (∿ 8,000 to 3,600 BP). The increase of *Casuarina* is interpreted as indicating slightly drier and cooler conditions during the late Holocene (after ∿ 3,600 BP) even though the input of pollen from both groups is regarded as being of non-local origin (Macphail, 1975a).

Pollen analysis of a core of lake clay from Crown Lagoon 20 km east of Oatlands demonstrates a co-dominance of *Eucalyptus* and Gramineae spp. (∿ 20% each) in the surface 30cm. This is preceded by a strong maximum and dominance of Gramineae spp. (20-47%) with abundant Chenopodiaceae (20-30%) between 30 and 80 cm depth. Although it has not been possible to ^{14}C calibrate this sequence the surface two zones mentioned here are clearly biostratigraphic correlates of local zones 1 and 3 at Lake Tiberias. The pollen profile indicates that a late Last Glacial steppe-grassland was replaced by *Eucalyptus* savannah-woodland during the early Holocene (Sigleo, pers. comm).

Pollen studies of cirque lake sediments at Adamsons Peak; Tarn Shelf, Eagle and Beatties tarns at Mt. Field; and in the glaciated Lake Vera east of Frenchmans Cap indicate that before ∿ 11,500 BP alpine grasslands and herbfields were widespread and that these were successively replaced in late glacial and early Holocene times (∿ 11,500 to 8,000 BP) by an expansion and regional upslope migration of alpine coniferous and sclerophyll heath, subalpine mixed woodland with *Eucalyptus*, and temperate rainforest. It is suggested that there was a relatively rapid increase in temperature and precipitation between ∿ 11,500 and 9,500 BP, and that the rising *Eucalyptus* climatic timberline, defined by the summer 10°C isotherm, maintained a west to east gradient sub-parallel to modern climatic timberline as climatic conditions improved towards an 'optimum' between 8,000 and 5,000 BP. The optimum may have been slightly warmer and moister than the succeeding climate which may have been slightly cooler and drier. Macphail (1975b) points out that any such fluctuations of Holocene climate were extremely small and that no major change occurred after the main late glacial-early Holocene period when temperature and precipitation increased fairly rapidly.

In southeastern and southwestern Tasmania there are three kinds of widespread geomorphological evidence from which it is possible to make some interpretations relating to climatic changes viz., periglacial forms and slope deposits, aeolian dunes and alluvial deposits.

The widespread occurrence of screes, blockfields, blockstreams, talus and gelifluction deposits above 450 m was taken by Davies (1967, 1974) to indicate that periglacial processes which caused fracturing and downslope movements of rock debris were general on the high ground of both southeastern and southwestern Tasmania during the Last Glaciation. In addition, rhythmically stratified screes and *grèzes litées* have recently been found in several localities. Collectively these deposits indicate general instability of the ground surface induced by severe winter frost conditions and indicate that the Last Glacial tree line occurred below 450 m. Recent research has shown that on steep slopes and on brittle rock types which are already strongly fractured, gelifluction, rhythmically stratified screes and *grèzes litées* have a discontinuous distribution down almost to sea level (Figure 6). This distribution suggests that mean annual temperature depression was probably greater than the 5°C estimate of Davies and may have been approximately 8°C. It also implies that the boundary of the climatic timberline was not regular and locally at least lay well below 450 m. The mosaic of areas of unstable slope deposits and more stable surfaces at low elevation probably maintained a mosaic of vegetation associations adjusted to different combinations of habitat variables rather than a continuous forest cover and stable ground surface.

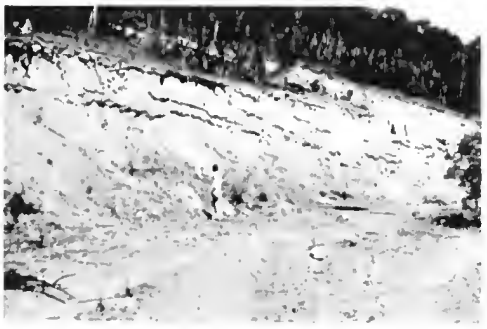

Figure 6 Rhythmically stratified scree deposits in Permian mudstones and sandstones near New Norfolk.

Radiocarbon dates of > 40,000 BP (I-8155, Wasson pers. comm.) on charcoal from a paleosol that separates an underlying gelifluctate from overlying *grèzes litées* at Ferntree, Mt. Wellington and an assay of > 37,000 BP (SUA-309) on charcoal and wood fragments in gelifluction deposits at Gellibrand Point, South Arm demonstrate that more than one major generation of gelifluction deposits occurs in southeastern Tasmania. The latest and most widespread generation is of late Last Glacial age during which movements of deposits continued until after 14,200 ± 700 BP (GaK-486) (Davies, 1974), as indicated by the superposition of a gelifluction deposit on a paleosol in the Florentine Valley of southwestern Tasmania.

On both sides of the lower Derwent Valley there are numerous areas of low sand dunes and in the southern midlands lunettes occur on the eastern margins of Lake Tiberias and Crown Lagoon. Nicolls (1957, 1958) considered that the low dunes of the Derwent Valley and lunettes of the northern midlands were produced by deflation of fine sands from river and lake beds, and alluvial

terraces by westerly winds in the drier eastern part of Tasmania during the Last Glaciation. Davies (1967) suggested the possibility that some of the dunes were either formed or modified during a more arid phase in the mid Holocene. Many dunes adjacent to rivers and lakes were aboriginal occupation sites, and where they have been studied at Crown Lagoon, Old Beach, Bridgewater and Glenfield (Sigleo and Colhoun, 1975; Sigleo, 1976) the evidence indicates that man was mainly responsible for the disturbance and modification of the dune forms in mid and late Holocene times. A ^{14}C date of 15,740 ± 700 BP (SUA-576) from a dunefield at Malcolms Hut Road near Richmond, which was not an aboriginal occupation site, supports a late Last Glacial age for the widespread aeolian erosion and deposition that formed the primary dunes.

One of the most impressive geomorphological characteristics of southeastern Tasmania is the great number of small valleys with thick alluvial deposits. Studies of the Tea Tree Rivulet by Goede (1965, 1975) showed that there was strong alluviation of the valley floor between 6,200 ± 200 BP (GaK-1146) and 3,040 ± 90 BP (GaK-1677), as indicated by substantial quantities of charcoal in the deposits. Goede suggested that the increased alluviation could have been the result of warmer and drier conditions in the mid Holocene. He also recognised the presence of reddish horizons of burnt clay and found an aboriginal artifact in the alluvial sediments (Figure 7). These facts indicate that aboriginal man was certainly influential in causing the increased alluviation and must lead to a reconsideration of whether the increased alluviation is really a response to climatic change or not.

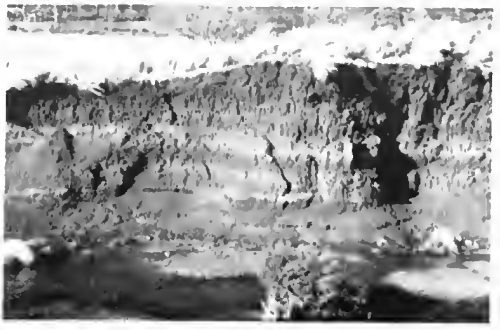

Figure 7 Alluvial clays showing fire horizons in the Tea Tree Rivulet

Similar alluvial deposits in the Barilla Valley east of Hobart contain charcoal horizons that have been dated to 1,160 ± 100 BP (GaK-651) (Stephens, pers. comm.), 4,650 ± 120 BP (GaK-488) and 7,900 ± 460 BP (GaK-487) (Davies, 1967, 1974). Davies suggests that the alluviation of the Barilla Valley was due to aboriginal burning and to slightly warmer and drier climatic conditions in the mid Holocene than at present. While it is easy to substantiate the occurrence of fire in these catchments, it is difficult to demonstrate from geomorphological evidence that a significant climatic trend towards warmer and drier conditions occurred.

Many valleys in southeastern Tasmania contain alluvial sediments and fan deposits of Last Glacial age as well as of Holocene age. Similar alluvial fan deposits are also known from along the Gordon and Scotts Peak roads in southwestern Tasmania where they are associated with scree and gelifluction deposits. Further investigation of these alluvial fills and fan deposits is needed not only to determine the quantities of Holocene and Pleistocene deposits but also to differentiate the changing conditions of alluvial sedimentation in response to both climatic changes and culturally induced changes of vegetation cover.

CONCLUSIONS

The biogeographic and geomorphologic evidence discussed indicates that when aboriginal man entered northern Tasmania and migrated southwards, mean

temperatures may have been as much as 8°C lower than present values; precipitation was probably significantly reduced over the whole state, and vegetation formations were much more open than the forested conditions seen by the first Europeans. The evidence indicates that the same climatic gradients existed then as today, with more humid maritime conditions prevailing in the mountainous southwest than in the drier continental conditions of the northern, midland and eastern areas of the state. The apparent widespread extent of alpine grassland and herbfield in the southwest was probably a response to decreased temperatures which also influenced the geomorphic processes that resulted in the widespread production of scree, blockfield, blockstreams and gelifluction deposits on high ground. The apparent widespread extent of grassland and steppe-grassland on the northwest lowlands and midlands was probably a response to aridity which also contributed to the formation and widespread occurrence of low sand dunes and lunettes.

The contemporaneous production of periglacial and associated slope deposits with aeolian and alluvial deposits in the same regions during the late Last Glacial stage suggests that seasonal variations of climate were geomorphologically more effective than during the Holocene. Severe winter frosts caused strong physical weathering and facilitated downslope movement of rock debris on high ground and steep non-forested slopes. Snow cover augmented flooding in spring which, in a landscape of unstable slope materials and reduced vegetation cover, caused severe erosion of surficial deposits and their deposition as fans or thick alluvial fills at the exits and in the floors of the valleys. After the spring floods, strong summer drought conditions prevailed over northern and eastern Tasmania and permitted wind erosion of sands and clays from bare surfaces, dried up river beds, lake beaches and exposed lake floors. The transported sands and clays were deposited on vegetated areas leeward of their sources. The greater efficiency of these seasonally induced geomorphological processes in the extraglacial regions of northern, midland and southeastern Tasmania during the Last Glaciation suggests that there may have been larger seasonal ranges or greater short period variability of both temperature and precipitation under conditions of increased continentality than under the more maritime conditions of the Holocene. This suggestion needs further investigation as the effects may to some extent be the product of increased efficiency of erosional processes because of reduced vegetation cover, which would act in the same direction and increase any effects of greater seasonal variation or short term variability of temperature and precipitation parameters.

In these environments aboriginal man would have moved freely over the landscape and could have migrated rapidly to eastern and southeastern Tasmania after he first arrived in the region. Although only three sites of Pleistocene age are presently known it is to be expected that the drier northern, midland and southeastern lake and riverine sites would be preferred to the colder alpine montane environments of the southwest. However the evidence of Goede and Murray shows that aboriginal man at least made journeys into the southwest during the late Pleistocene.

The biogeographic evidence from Lake Tiberias, Crown Lagoon and the mountain cirque lakes of the southwest studied by Macphail (1975a, b) and Sigleo (pers. comm.) shows that there was a rapid increase of temperature and probably also of precipitation at the commencement of the Holocene. This was accompanied by the rapid expansion of *Eucalyptus* forest in eastern Tasmania and a rapid expansion through alpine sclerophyll shrubs, alpine mixed forest to temperate rain forest in southwestern Tasmania during the early Holocene. The combined effects of the climatic changes and forest expansion was to cause a decrease in the intensity and erosional efficiency of terrestrial geomorphic processes. The likely action of aboriginal man, using his chief agent fire, would be to contest the forest encroachment on his open environment. Evidence for significant climatic changes during the middle and late Holocene is equivocal, but the widespread presence of charcoal in sediments suggests that extensive firing of scrub and forest by aboriginals may have been sufficient to induce periodically high rates of erosion and cause alluviation in the valleys of eastern Tasmania.

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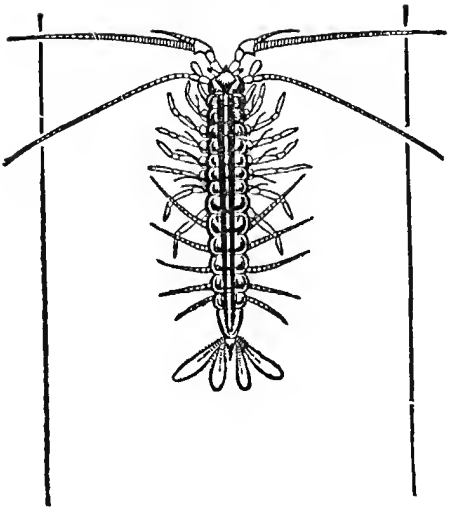

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DESCRIPTION OF A NEW SPECIES OF HELICARION (STYLOMMATOPHORA: HELICARIONIDAE) IN TASMANIA

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ABSTRACT

A species *Helicarion rubicundus* is described. Comparative data on south eastern Australian species are presented. This paper is part of a study of the genus *Helicarion* in Australia.

INTRODUCTION

Previous studies of the genus *Helicarion* in Australia have been brief. Material is still lacking from some areas in Tasmania. Some anatomical data have been presented by Hedley (1891) for *Helicarion cuvieri* Ferussac. The genus is one of slug-like animals characterised by a reduced shell consisting entirely of conchin. The genotype, *Helicarion cuvieri*, was illustrated by Ferussac (1819) and later established in the description (1821) of the species and genus.

It is important to realise that in the complex Helicarionidae the complete review may require many years. But a study of genus *Helicarion* is in preparation by one of us (R.C.K.). A considerable number of animals already studied has facilitated the completion of this paper.

The genus is represented in south eastern Australia by several species:

1. *Helicarion cuvieri* Ferussac, 1821; southern Tasmania.
2. *Helicarion niger* (Quoy & Gaimard, 1832); Gippsland, Victoria.
3. *Helicarion freycineti* Ferussac, 1821; eastern New South Wales.

The species *Helicarion virens* (northern New South Wales) together with other northern forms placed in various genera by Iredale (1937) require further study. Many forms occurring in south eastern Australia have been compared with the species described here but discussion is beyond the scope of this paper.

ACKNOWLEDGEMENTS

Thanks are due to Mr. Peter Boyer for photographs of the holotype. Gratitude is expressed for valuable discussion with Dr. B. J. Smith and Mr. R. Burn of the National Museum of Victoria and for study facilities for R.C.K. at that institution; for discussion with Dr. M. J. Bishop (Queensland Museum) and continued assistance from Miss A. Green and Mrs. E. Turner (Tasmanian Museum). Gratitude is expressed to the Directors and staff of the National Museum of Victoria, the Tasmanian Museum and the Queen Victoria Museum for the use of the collections in their care. The Science and Industry Endowment Fund microscope on loan to one of us (R.C.K.) has materially assisted in this work.

DESCRIPTIONS

The genus *Helicarion* Ferussac is recognised by H. & A. Adams (1858) as of rotundly oval heliciform fragile shells with thin epidermis, short spire and large aperture. The mantle has accessory lobes (lappetts) of which the right posterior frequently partly covers the shell. The foot is posteriorly truncate with a recessed caudal gland. Tryon (1884) noted the swollen body whorl, oblong triangular aperture, the inability of the animal to withdraw fully within the shell and the tripartite foot sole. Gray (1855) notes the elongate neck and the imperforate shell. A summary of various aspects was provided by Smith (1972) together with a figure. Solem (1966) presented a classification of the family Helicarionidae. He includes genus *Helicarion* in a subfamily Helicarioninae. Some discussion of anatomical data are presented by Van Mol (1973).

Helicarion rubicundus, sp. nov. (Plate 1)

Diagnosis

Helicarionid snail with thin transparent large depressedly globose shell composed of conchin, yellowish, spire flatly convex, imperforate, aperture large, animal banded red with tail dorsally green, caudal mucus red.

Etymology

The name *rubicundus* is chosen to draw attention to the red verrucose bands observed in the live animal.

Description

Shell (see Plate 2) of three and one-half whorls, suture barely depressed. Protoconch about one and one-half whorls increasingly convex with growth, sculpture very faint low rounded radial riblets almost obsolete at lower suture relatively bold above crossed by extremely fine close spiral faintly beaded lirae. Adult sculpture passes smoothly through juvenescent stage coincident with clear widening of whorl and increasing strength until radial ribs distinctly bolder occasionally sharpened. After about two and one-quarter whorls an occasional rib is clearly raised and sharpened. The surface develops undulations broadening with growth displaying subsidiary close fine radial riblets and primary radials become increasingly curved from the sutures. Sutural margin distinct flattened or slightly depressed, supra-sutural, clearly sculptured with radial slightly curved oblique rounded ribs. Whole shell sculpture crossed by very close spiral lirae fainter toward periphery, body whorl with beading weakly visible near suture.

Animal with red verrucose bands radiating from the mantle to foot margin, tentacles red, lappetts and dorsal keel of tail green, foot fringed red. Central portion of tripartite foot sole smoothish, lateral sections with numerous transverse deeply incised tubercles, broadest below visceral

region rounded anteriorly tapering posteriorly, the central portion depressed and tapering regularly posteriorly to less than one-eighth the width at tail. Laterally foot with clearly defined slightly protruding margin at least 1 mm thick, darker coloured than pinkish sole, marked with regular vertical tubercles. In a shell of dimensions 16 mm maximum, 14.5 mm minimum, the elongate left shell lappett stretches diagonally one-third the distance across the surface with dimensions 14 mm by 9 mm greatest at mantle attachment. Right shell lappett capable of covering the apex of the shell to almost one-half surface diameter attached to mantle just posterior to pneumostome, resting slightly diagonally across shell on to tail with maximum dimensions 16 mm by 9 mm over apex tapering to about 4 mm at the posteriorly tubular fold, anteriorly attached to mantle for 10 mm. Anterior from pneumostome a distinct body lappett of 3 mm maximum width is attached over 9 mm. Lappetts attach to mantle above a distinct collar about 7 mm diameter from which mantle extends 5 mm along neck and laterally 4 mm from pneumostome edge. Optical tentacles situate 2.5 mm from pinkish smooth muzzle, about 1.5 mm apart in average animal, inferior tentacles arise immediately above lateral extremity of foot just to rear of muzzle. Genital atrium aperture immediately below right optical tentacle, penis protruding from supra-posterior side of aperture, elongate tubular pink at least 6.5 mm long by 3 mm diameter extended from atrium. Pneumostome situate between mantle and ridge of lappett, subtriangular, about 4.5 mm across bright pink posterior extremity, surrounded by paler glandular area. Foot elongate quadrangular flattened behind visceral hump where laterally sub-keeled, tapering to delta shape over last one-quarter of tail to small but prominent caudal horn above caudal mucus gland (foss). Whole body covered with irregular tubercles increasing in size posteriorly from tentacles, irregular very large at posterior dorso-lateral edges, tubercles covered with close minute pustules.

Anatomy

Pharynx short compact, jaw bright orange clearly visible when muzzle protruded, arched above buccal aperture, arcuate with small central projection, triangular in cross section, tapering acutely to rounded extremities, dimensions 2 mm by 0.4 mm. Radula formula slightly variable, usually 80-18-1-18-80 of about 120 rows. In one example the rachidian was absent, in others one less lateral and two or three fewer marginals can occur. Rachidian tricuspid, mesocone elongate, gently curved to rounded tip. Ectoconal cusps set almost half way posteriorly, sharply pointed forward. Lateral teeth with elongate mesocone, a minute endoconal cusp about one-third distance from tip pointing centrally, a well developed sharpened laterally forward pointing ectoconal cusp parallel with ectoconal cusps of central tooth. A well marked cusp like projection facing the central tooth at the posterior one-third of the laterals marks the raised curved anterior portion of the tooth as distinct from the base. Marginal teeth bicuspid clearly curved slender with the ectocone situate posteriorly from mesocone. Rachidian base plate anteriorly broad, thickened, lateral aspects with central concave curve. Lateral base plates elongate smoothly distinctly convexly curved toward rachidian (Plates 3 - 5).

Reproductive System (Figure 1)

Penial complex with penis compressed distinctly at base. Epiphallus (EP) terminally laterally twisting to ephiphallic gland (EG; sinuate appendage of Solem, 1966, part of flagellum) at insertion of vas deferens (VD). Surface of gland ornamented with up to 10 rows of variable raised protruberances proximally, few at epiphallic junction (Figure 1b). Gland internally an elongate moderately capacious lumen extending from vas deferens insertion adjacent distal protruberances passing into small pockets corresponding with spermatophore spines, curving into very short sinuation of flagellum (Q). Epiphallic duct with longitudinal minutely interrupted pilasters converging at retractor muscle (RM), from which penial duct lined with lateral folds to constriction, the whole within a muscular integument. At constriction (junction of evertible section) duct enclosed within muscular walls from where a strongly contorted pilaster-like

structure (Figure 1c) extends into base of penis and terminates in a very small bulging rounded verge (VE). Penial duct lined with lamellate transverse ridges thickly enclosed within elongate muscular tissue. Penial sheath distinct thickened at base, connected by a slim sheath retractor 3 mm from atrium to retractor caecum across epiphallus. Retractor caecum (RC) small distinct abruptly curved, about 1.5 mm long, 1 mm diameter, passing into penial retractor (RM). Epiphallus may be sharply recurved at caecum or smoothly curved with sheath retractor drawn tightly across. Penis 6-7 mm long from atrium to constriction (Figure 1c), on longitudinal section a purplish fluid spread rapidly staining adjoining tissue. Dart sac (or sarcobelum of Van Mol, 1973) absent. Spermatophore (Figure 2) head with a single coil and 12 branching spines in 3 groups, a plump (0.4 mm) short (3 mm) 'head' with a long (8 mm) 'tail'. Bursa copulatrix (Figure 1, SP; spermatheca of Hedley, 1891) connected to vagina hy a short 2 mm external diameter muscular pedicel expanding rapidly but variably into centrally or sub-centrally swollen chamber from which the organ is angled and pointed posteriorly, variably like a high heeled boot. Internally bursa is lined densely with thin zig zag pilasters (some straight) closely spaced. Initial section of pedicel duct about one-fifth of length, lined with close pilasters opens to small vestibule from which duct, lined with larger distinct pilasters widens abruptly into bursa chamber. Vagina (VA) a short (5 mm) narrow muscular organ lined with longitudinal pilasters leading to bursa duct, becoming a moderately inflated post-uterine oviduct curving sharply from vagina to very short thin duct connecting with uterus. Spermoviducal complex (Figure 1, OD) of two ducts closely appressed, the uterine section (H) elongate swollen pale grey in tight large folds, internally duct wide thin; prostate section (E) relatively narrow thin spongelike. Initial section from post-uterine duct strongly convoluted with prostate terminating on second arm of convolution. Vas deferens (VD) a strongly contorted flattened duct with numerous folds firstly, passes from prostate across vagina to insert with epiphallic gland adjacent to on proximal aspect of distal bulges, opposite curve of sinuation, about half-way between flagellum tip and retractor muscle. Bursa copulatrix in situ rests dorsally on spermoviducal complex attached with connective tissue. Uterine section swollen at junction with bright yellow bilobately produced hulbous albumen gland (AG). Hermaphrodite duct (HD) fine strongly convoluted inserting laterally or posteriorly between lobes of albumen gland where it gives off a fine duct to talon. Talon (T) a small elongate oval dark body (0.8 mm by 0.5 mm) embedded within tissue of gland dorso-laterally from duct. Hermaphrodite gland (HG) of irregular alveoli arranged on 3 ducts, claw-like, embedded within digestive gland just below apical whorl attached to visceral wall by central duct. The talon in *Helicarion* is described by Van Mol (1973).

Digestive Complex (Figures 3-4)

Buccal mass about 5 mm long with retractors leading from subterminal posterior to attach ventro-laterally to oesophagus across narrow neck of gullet. Oesophagus (AE) commonly inflated at first, then narrowing abruptly before entering muscular crop (C) and stomach (S) to digestive gland (DG). Posterior oesophageal duct (figure 4, PE) very long, about 38 mm, coiled through lobes of digestive gland to rectal duct (R) ultimately opening at anus on dorsal aspect just within pneumostome vestibule (PA). Visceral mass (V) set basally in enlarged body cavity. Digestive gland bilobate leading from apical whorl over stomach as an elongate flap appressed above and between coil of oesophagus with inferior lobe a narrow flap appressed alongside posterior oesophagus to rectal duct. Kidney (KD) on dorsal aspect of viscera, somewhat triangular with a rounded apex curving above oesophagus. Ureter arising from recurved primary uretal lobe of kidney passing toward lateral curve of oesophagus then recurved and appressed to rectal duct. Heart (HT) antero-laterally adjacent to and partly overlapped by kidney. Circum-oesophageal ganglionic complex distinctly posterior to buccal mass resembling that in other Stylomatophoran groups.

Plate 1 Holotype of *Helicarion rubicundus* sp. nov. (Photo P. Boyer)

Plate 2 *Helicarion rubicundus sp. nov. live animal. (Photo R. E. Kershaw)*

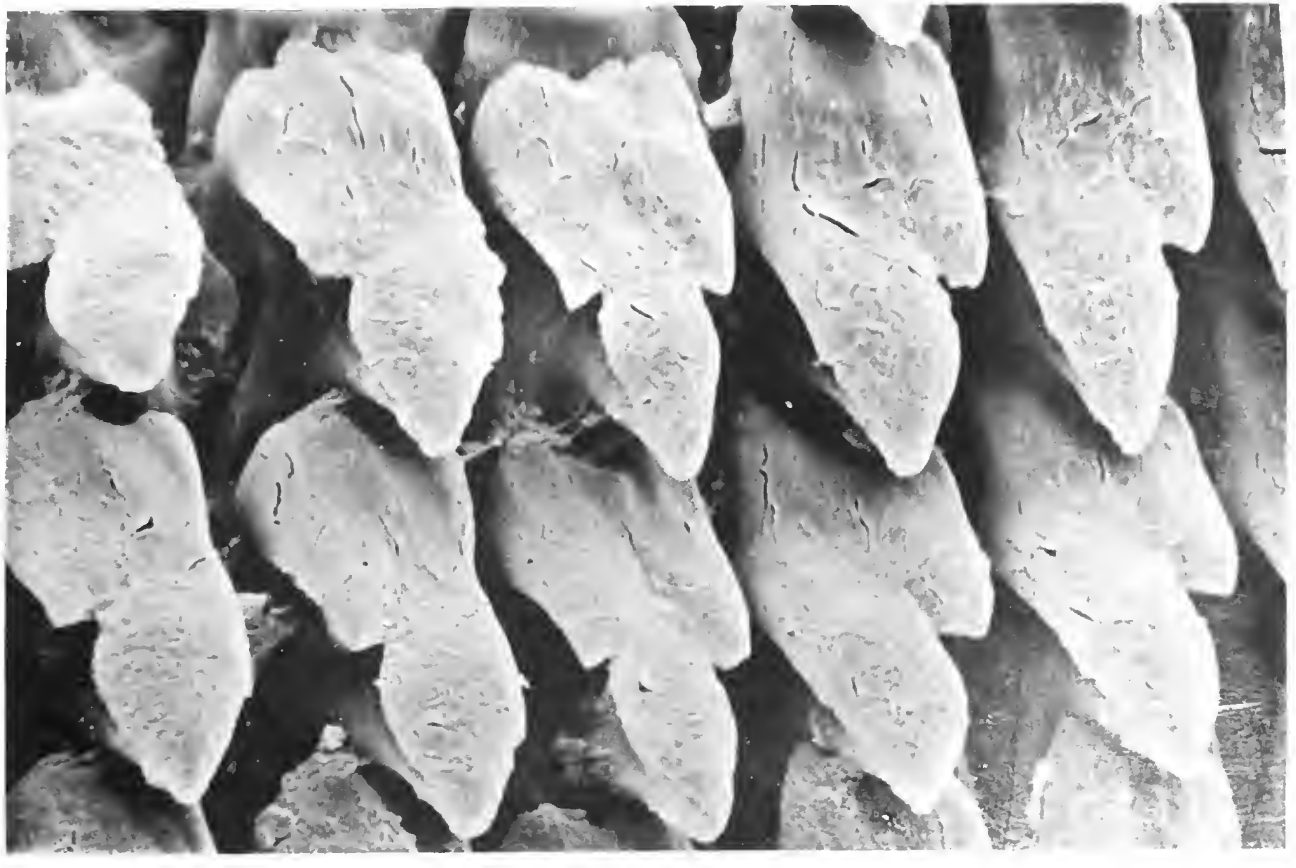

Plate 3 *Helicarion rubicundus* sp. nov. central and marginal teeth.

(Plate enlarged from SEM micrograph provided by Dr. B. J. Smith, National Museum of Victoria.)

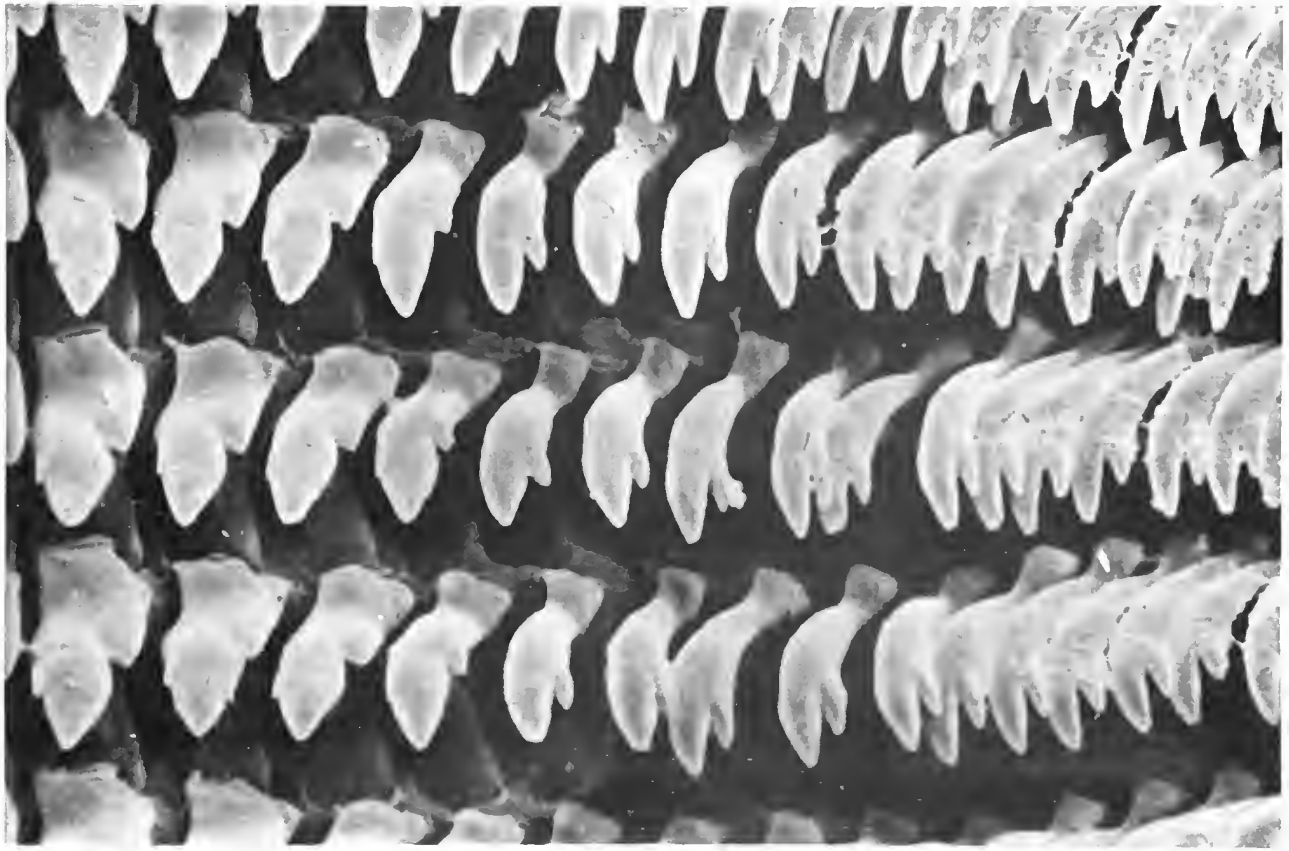

Plate 4 *Helicarion rubicundus* sp. nov. lateral and marginal teeth.
(Plate enlarged from SEM micrograph provided by Dr. B. J. Smith, National Museum of Victoria.)

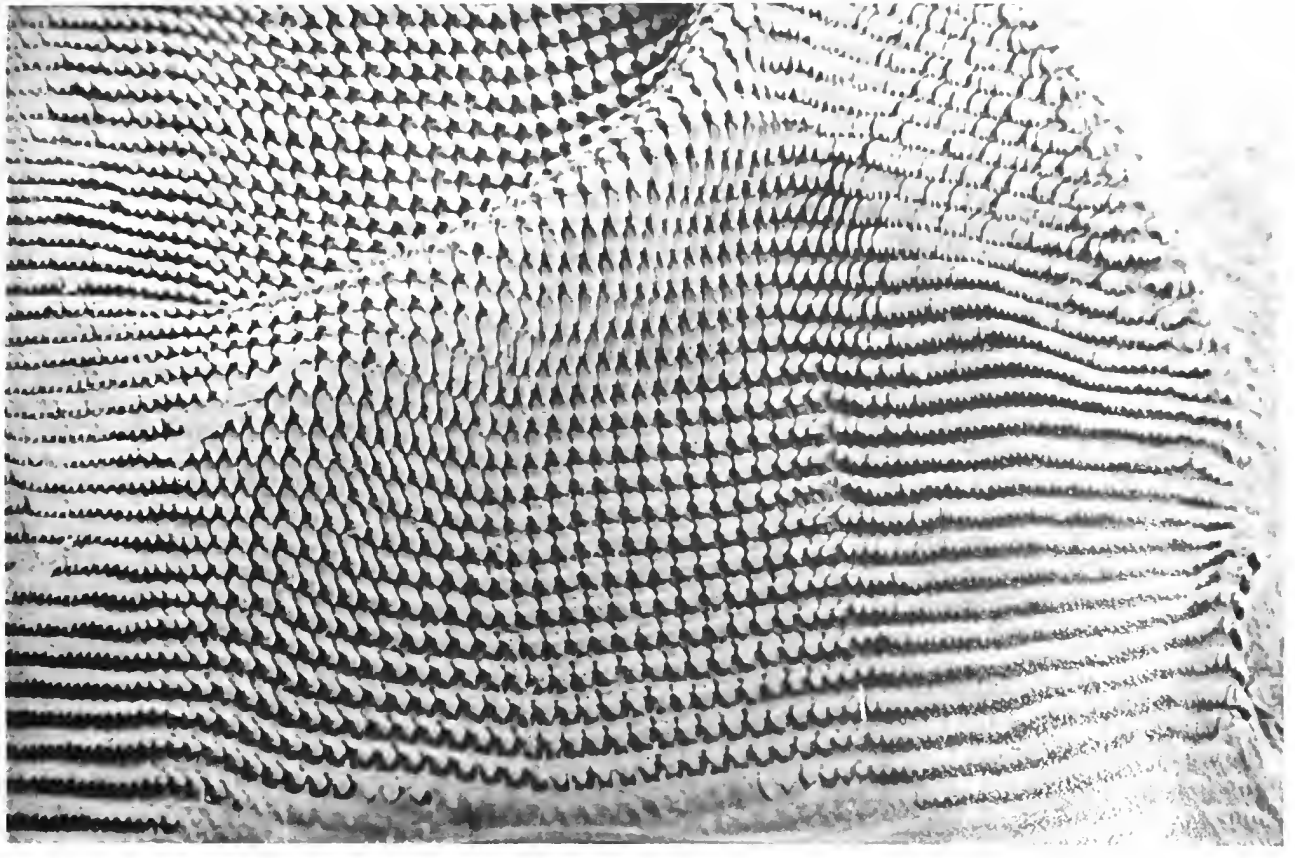

Plate 5 *Helicarion rubicundus* sp. nov. section of radula.

(Plate enlarged from SEM micrograph provided by Dr. B. J. Smith, National Museum of Victoria.)

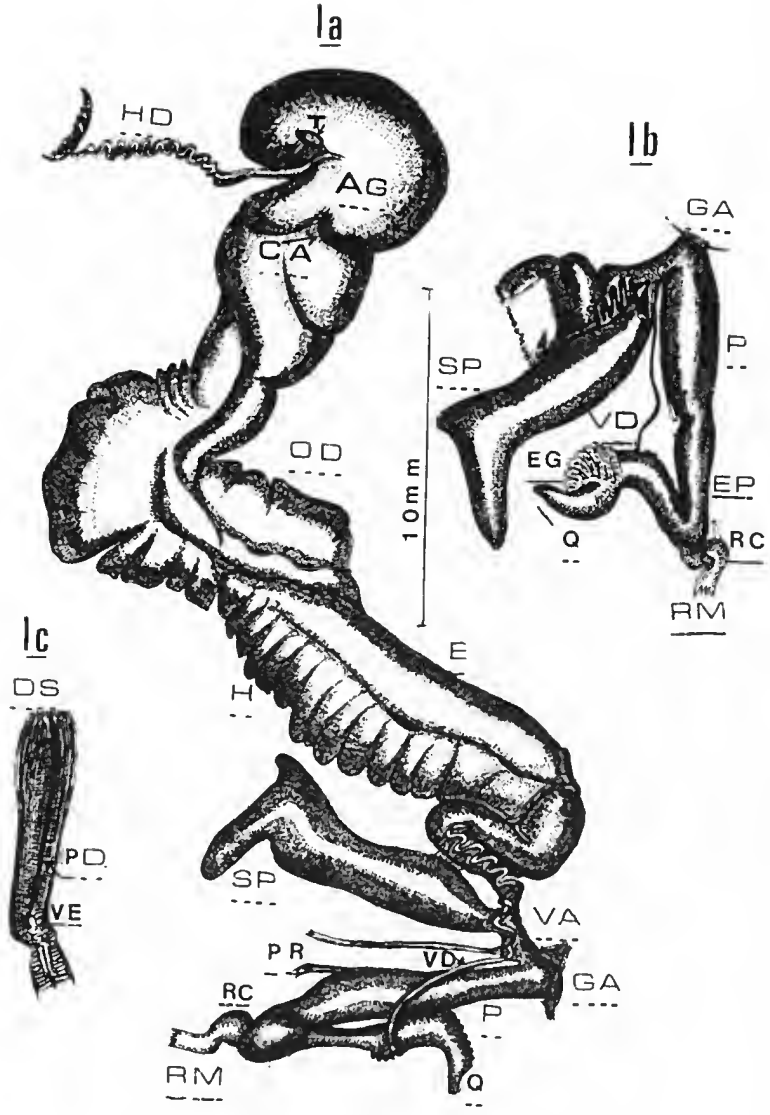

Figure 1 a Reproductive system of *Helicarion rubicundus* sp. nov.
1 b Detail of genital complex.
1 c Section through the penis.

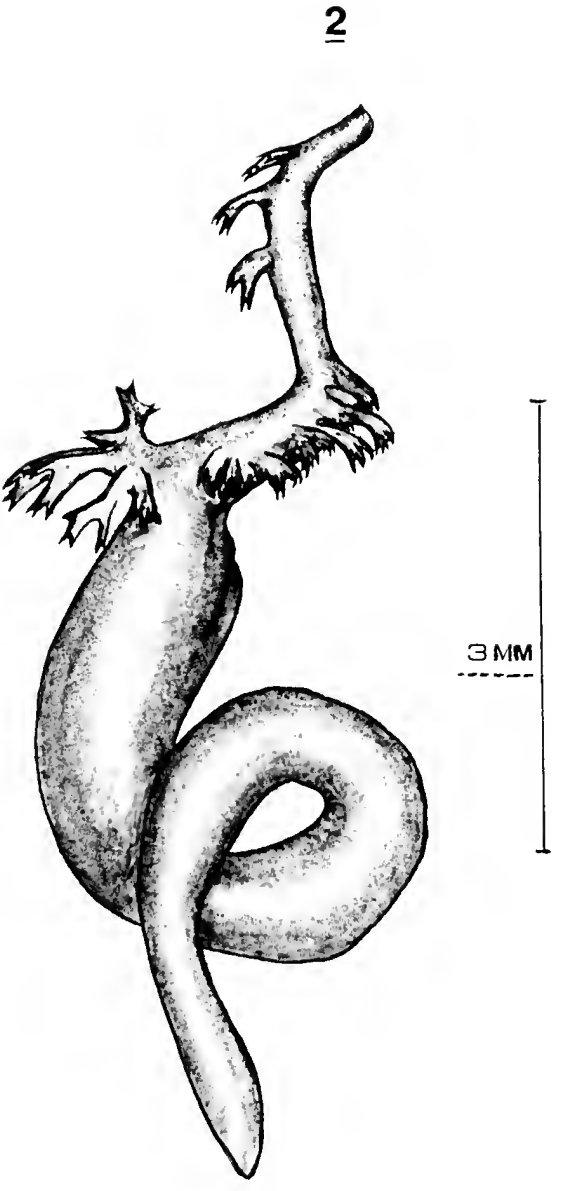

Figure 2 Spermatophore of *Helicarion rubicundus* sp. nov.

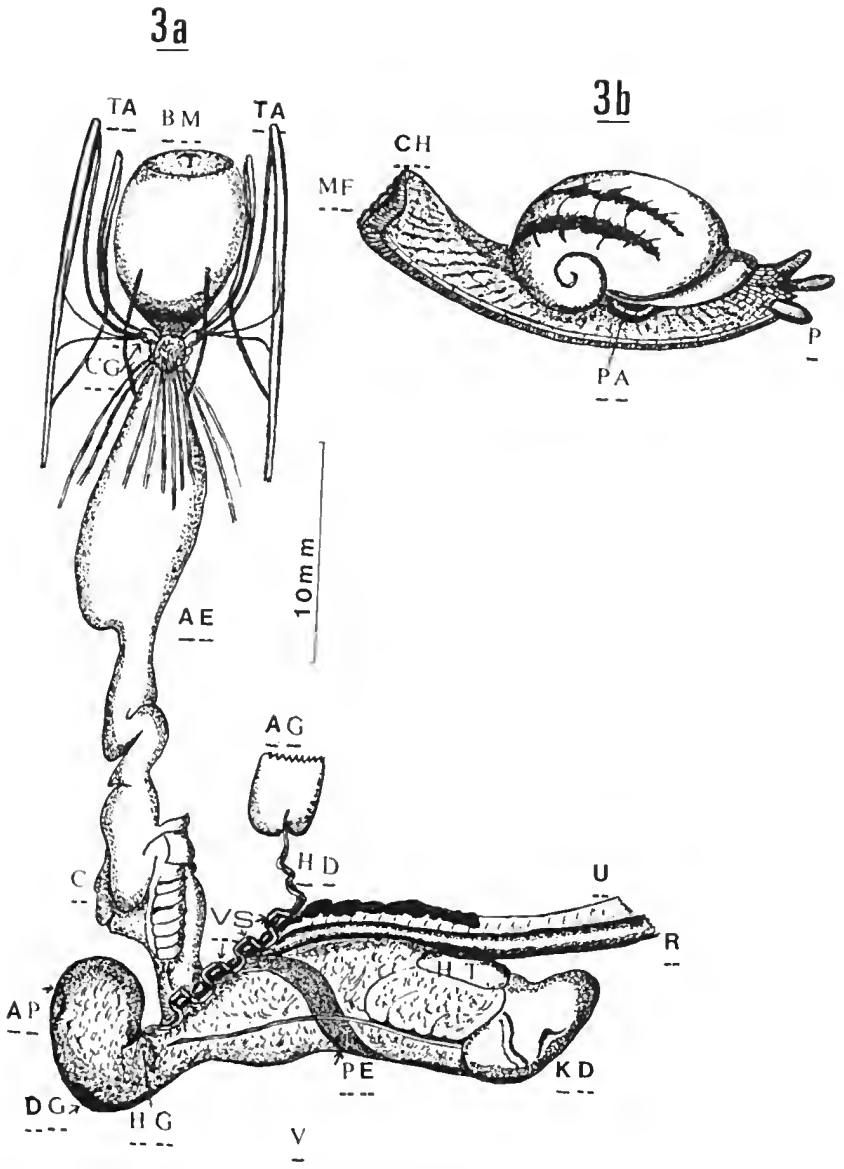

Figure 3 a Digestive system of *Helicarion rubicundus* sp. nov.
3 b Animal with shell and lappetts removed.

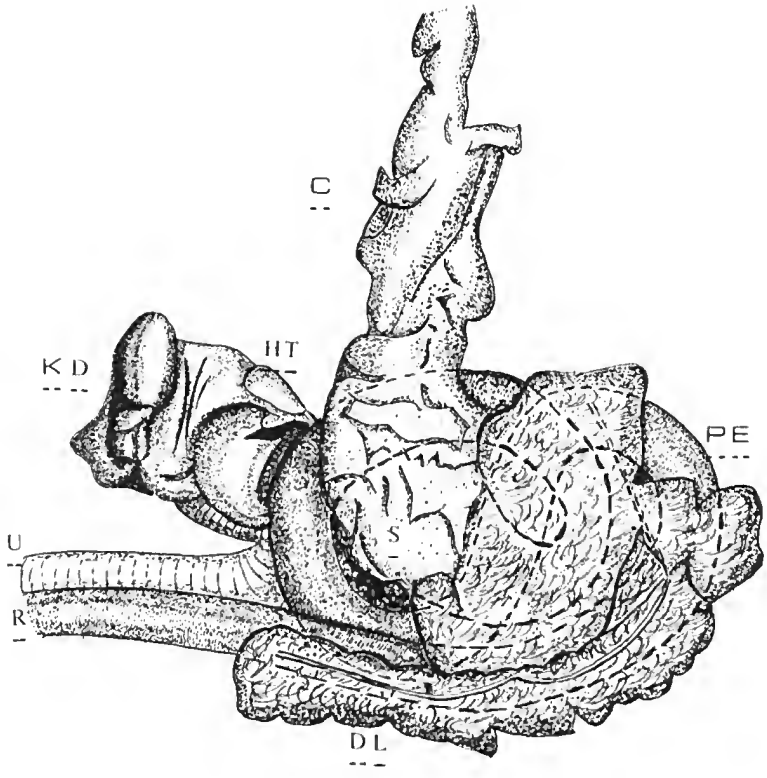

Figure 4 Digestive gland partly removed to show detail.

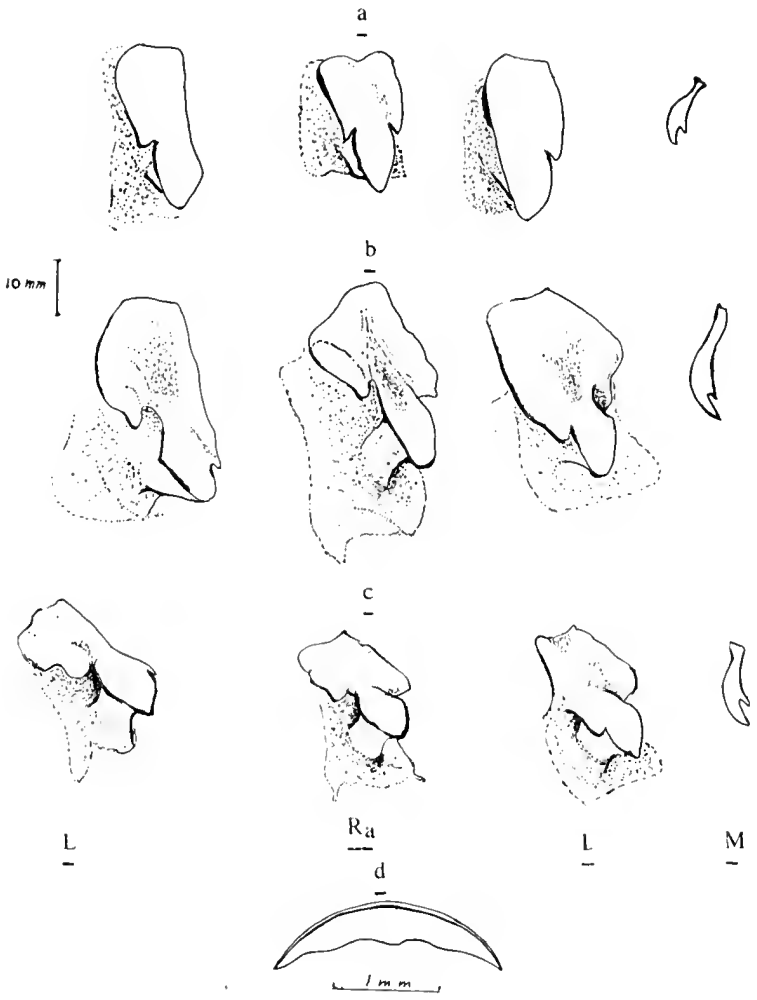

Figure 5 Comparison of radula teeth (tracings from SEM micrographs). Scale of photographs shown.

5 a *Helicarion rubicundus* sp. nov.: magnification of central and lateral teeth 800 x, marginal tooth 400 x.

5 b *Helicarion cuvieri* Fer.: magnification of central and lateral teeth 2000 x, marginal tooth 720 x.

5 c *Helicarion niger*(Q & G): magnification of central and lateral teeth 1500 x, marginal tooth 780 x.

5 d *Helicarion rubicundus* sp. nov.: jaw.

Type Material

Holotype: Tasmanian Museum reg. no. E 9028 from litter in a fern gully on the north-east flank of Hawkes Hill near Eagle Hawk Neck, south-east Tasmania. Grid reference 575800ME 5238400MN, Storm Bay 1:100 000. Collected A. J. & J. A. Dartnall, August 1971; entire animal preserved in alcohol. Paratypes: two specimens Tasmanian Museum reg. no. E 9029, two specimens Queen Victoria Museum, Launceston, no. 1975/9/1, two specimens National Museum of Victoria no. F 29517. Collected under litter, wood and stones in fern gully, Eagle Hawk Neck by A. J. Dartnall and R. C. Kershaw, 10 June, 1973 and by R. C. Kershaw, 26 April 1974, between 40 m and 200 m above sea level.

Dimension of Type Shells

(mm)

	Maximum	Minimum	Approx. foot length (preserved)
Holotype			
E 9028	16.5	12.5	38.0
Paratypes			
E 9029 a	18.0	13.5	31.0
b	18.0	13.0	27.5
1975/9/1 a	22.0	16.0	45.0
b	12.0	10.0	31.0
F 29517 a	15.3	12.5	31.0
b	16.0	12.5	27.5

VARIABILITY IN *H. rubicundus*

Variations observed relate to the maturity of the animal and genital organs. Some variation apparently occurs in inflation of the anterior oesophagus but this feature, not seen in other forms of the genus in Tasmania or Victoria, could not be evaluated. Slight shell variations include a more clearly defined protoconch, smoother adult sculpture, fine spiral lirae so close as to resemble striae. The clearly thickened aperture lip in some cases suggests that boldly raised ribs seen may be growth stages. These, approximating ten, are spaced further apart with age.

INTERSPECIFIC CHARACTERISTICS

1. Shell Size

H. rubicundus attains a diameter of up to 22 mm, *H. cuvieri* up to 16 mm, *H. niger* up to 13 mm, and *H. freycineti* to 19 mm in specimens observed to date. The spirally beaded protoconch sculpture is unlike any other morph yet studied. That of *H. cuvieri* consists of fine variable radial lirae with vague spirals, *H. niger* has very fine distinct spiral striae and *H. freycineti* has weak radial lirae with vague spirals a little like *H. cuvieri*. Shell colour is variable with most morphs yellowish or variously orange or greenish tinted. Shell sculpture is of value only as a guide due to the considerable variation. Features quoted are those most likely to be encountered.

2. Body Colour

H. rubicundus: red and green.
H. cuvieri: grey, greyish buff or white.
H. niger: black, greyish or pinkish buff often with darker extremities.
H. freycineti: buff.

3. Caudal Mucus Colour

H. rubicundus: red.
H. cuvieri: yellow.

4. Anatomy

Helicarion rubicundus is distinguished immediately by the presence of the small retractor caecum. Other Tasmanian forms have a very small section of the retractor which could constitute a degenerate or primitive caecum, a comment applicable to Victorian forms studied. *H. rubicundus* has the epiphallus from the epiphallic gland to the retractor lined with distinct pilasters, *H. cuvieri* has distinct pilasters to penial constriction, and in *H. niger* the ridges are of minute but distinct folds. There is no verge in *H. cuvieri*, *H. rubicundus* has a small rounded verge while *H. niger* has a small fleshy ridge. The vas deferens insertion in *H. rubicundus* is about half-way between flagellum tip and retractor muscle at a point about three-quarters length of flagellum, *H. cuvieri* about one-third the first and three-fifths to three-quarters the second section and *H. niger* less than one-third the first and three-quarters to nine-tenths the second section. *H. freycineti* differs completely in both the retractor caecum and flagellum. There is some resemblance in the caecum of *H. virens* as understood at present but none in the flagellum. The new species is distinct from Tasmanian and Victorian morphs in its pink penis, bright yellow albumen gland, distinctive bursa copulatrix and the oesophagus. No other form yet dissected has the distinct convolution at the spermoviduct-vaginal junction.

THE RADULA

Comparative tracings of the central, adjacent lateral and one marginal, teeth of *H. rubicundus* (Figure 5a), *H. cuvieri* (Figure 5b; Strathgordon Road) and *H. niger* (Figure 5c; Sandy Point, Waratah Bay, Victoria). The teeth of the new species are twice the size of the others, the rhachidian is relatively broad with the mesocone not narrowly elongate and posteriorly excavated as in *H. cuvieri*. The mesocone in *H. niger* is relatively broader and posteriorly depressed. Cusps are very pronounced in the new species. Despite wear in the teeth of *H. cuvieri* the distinctive shape and features distinguish it from the new species and all other species so far studied.

DISTRIBUTION

Helicarion rubicundus is known only from the type locality. The limits of distribution will need considerable research but it is not expected to extend beyond the region. The forest floor of the habitat is well covered with litter, the overhead canopy moderately dense. The snail favours moss covered logs on which its remarkable colouration provides some camouflage. Collecting has extended the original area down the hill-slope to the creek bank and under bark of a felled log. *Helicarion cuvieri* is confined to southern Tasmania as at present recognised. Distinct morphs exist in the highlands of the west, central and eastern regions and the lower levels of the north and Tamar Valley. Detailed work on these is in progress. *Helicarion niger* as at present recognised extends from Port Philip Bay to Wilsons Promontory and possibly into the Great Divide in Victoria. The study of other morphs in Victoria is also well advanced. It has not been established that *H. niger* exists in Tasmania and black animals thought to be this species differ in detail of the genitalia.

The new Tasmanian species is associated with *Caryodes dufresnii*, *Strangesta lampra*, rare *Tasmaphena sinclairi* and various endodontids.

It is hoped that the habitat will remain as undisturbed as possible because the known distribution is restricted.

DISCUSSION

The list by Iredale (1937) has provided a useful reference source. The relationships of his genera within Australia and adjacent regions remain to be dealt with in detail. Solem's (1966) work in Thailand has been invaluable in the current research into *Helicarion* with particular reference to taxonomy. Other fruitful work could be done in chromatographic investigation of caudal mucus constituents. The new species exudes mucus when irritated. Allan (1950) reported that *Parmavitrina planilabris* exuded purple mucus. Stimulation leads to evasive action and Hyman (1967) reports that the tail may break and then regenerate. A specimen with a truncated tail has been observed by R. C. Kershaw.

Studies by A. J. Dartnall in the South Australian Museum revealed that of seven shells in the May collection (reg. no. d 11312) four resemble *H. rubicundus*. Shell study suggests that *Luinarion castaneus* (Pfeiffer) has a distinct protoconch but in general the shell requires care in use for identification.

Current studies by R. C. Kershaw suggest that *Helicarion* may have reached Tasmania during the pre-Miocene Tertiary. These snails are at the southern limit of family distribution in Australia. Speciation in Tasmania would have been facilitated by the isolation during the Miocene when, also, the habitat of *H. rubicundus* may have been isolated. The features of this snail which are reminiscent of New South Wales forms and its size suggest that it is both relict and favoured by its habitat. The remarkable uniformity of the species suggests no interbreeding with *H. cuvieri* although this snail has been found not far away. The Bass Strait land bridge may have enabled exchange between the two southern states and island forms exhibit relationships which remain to be fully evaluated.

The absence of the rachidian tooth in one specimen of *H. rubicundus* is of interest. Solem (1959, p. 45) remarks on the basic nature of the possession of this tooth to the pulmonates. It is reduced or absent in specialised genera. Although the Helicarionidae appear to show specialisation it would be unrealistic to draw conclusions from this isolated case.

LIST OF ABBREVIATIONS USED IN THE FIGURES AND TEXT

AE	anterior oesophagus	MF	caudal foss
AG	albumen gland	OD	spermoviducal complex
AP	apex	P	penis
BM	buccal mass	PA	pneumostome
C	crop	PD	penial duct
CA	carrefour	PE	posterior oesophagus
CH	caudal horn	PR	penial sheath retractor
CG	cerebral ganglia	Q	flagellum
DG	digestive gland	R	rectum
DL	lobe of digestive gland	Ra	central tooth
DS	dissected penis	RC	retractor caecum
E	prostate	RM	penial retractor
EP	epiphallus	S	stomach
EG	epiphallic gland	SP	bursa copulatrix
GA	genital atrium	T	talon
H	uterus	TA	tentacles
HD	hermaphrodite duct	U	ureter
HT	heart	V	viscera
KD	kidney	VA	vagina
L	lateral tooth	VE	verge
M	marginal tooth	VD	vas deferens

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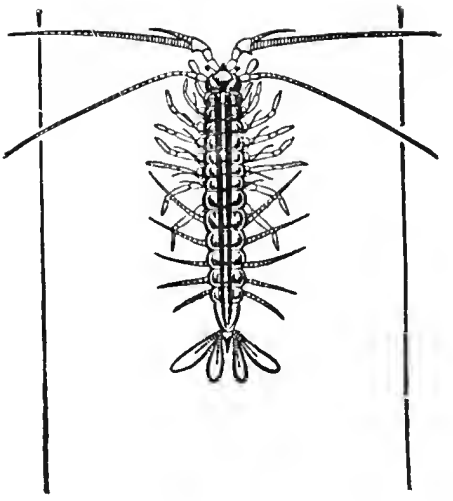
No. 63

RECORDS OF THE QUEEN VICTORIA MUSEUM LAUNCESTON



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A NEW SPECIES OF GALAXIAS (PISCES: GALAXIIDAE) FROM THE SWAN RIVER, TASMANIA

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ABSTRACT

Galaxias fontanus sp. nov. is described. The species appears confined to the upper reaches of the Swan River in eastern Tasmania.

INTRODUCTION

The fragmented nature of the distribution of Tasmania's endemic galaxiid fauna was commented on by Andrews (1976), and since his revision of the family in Tasmania, further evidence of this has been documented. Three new species of galaxiids have since been described (McDowall & Fulton 1978; Fulton 1978), each of which is restricted in its distribution to a single lake or two adjoining lakes and their tributary streams.

However, all of the endemic species so far described with the exception of *G. cleaveri* Scott are found in the water-rich central and southwestern parts of the state. No endemic species have been recorded from the drier east coast region, hence the species described below is the first to be collected from this part of the state. It was found whilst electrofishing in creeks and streams crossed by newly constructed forestry roads.

METHODS OF STUDY

Specimens were examined using techniques similar to those of McDowall (1970) and Hubbs and Lagler (1958), except that fin ray counts include all segmented rays, branched or unbranched, and vertebral counts exclude hypural centra.

Specimens of *G. fontanus* used in the study were collected by electrofishing from the upper reaches of the Swan River in eastern Tasmania. Type material has been deposited in the following museums (the abbreviations as shown appear in the text):

AMS	Australian Museum, Sydney
IFCH	Inland Fisheries Commission, Hobart
QVML	Queen Victoria Museum, Launceston
TMH	Tasmanian Museum, Hobart

Measurements of all type material have been included in the study with details of the holotype given separately. All other specimens not designated as types are retained in the collection of the Inland Fisheries Commission, Hobart, under catalogue numbers GF.1-2.

MATERIAL EXAMINED

Swan River (type locality) (9 specimens), 27 January 1976 W. Fulton and R. Mawbey; Swan River (type locality) (21) 22 February 1978 W. Fulton and R. M. McDowall. Size range: 53 - 82 mm SL, mean 60 mm.

SYSTEMATIC DESCRIPTION

Galaxias fontanus sp. nov.
(Figures 1 and 2)

Types

Holotype. TMH D1317: 78 mm TL; collected 22 February 1978 by W. Fulton and R. McDowall from the type locality.

Type locality: Swan River, eastern Tasmania, where state forestry MG road crosses this river. (Tasmap 1:100000 series Break O'Day map sheet grid. ref. 8514-906 678. Lands Department of Tasmania.)

Paratypes. TMH (4) D1318-D1321: Collected 22 February 1978 by W. Fulton and R. M. McDowall, type locality. QVML (4) 1978/5/72, QVM type 254: collected 22 February 1978 by W. Fulton and R. M. McDowall, type locality. AMS (4) AMS 1.20157-001: collected 22 February 1978 by W. Fulton and R. M. McDowall, type locality.

Etymology

The name fontanus is from the Latin meaning spring and refers to the probable origin of the Swan River.

Diagnosis

Differs from all other species of *Galaxias* by usually having an extra pore in the supramaxillary series (Figure 3). Differs from closely related species *G. johnstoni*, *G. pedderensis* and *G. olidus* in its more forward placement of the dorsal fin, fewer pectoral rays and the presence of well developed lateral canine teeth which are weak or lacking in the other three species. Differs from another closely related species, *G. brevipinnis*, in the absence of pyloric caeca and in having fewer dorsal, anal and pectoral rays and fewer vertebrae.

Description

A broad bodied species with wide head, markedly flattened between the orbits. Eye large with upper margin level with dorsal surface and lower margin at about half depth of head. Jaws about equal, gape wide and reaching almost to level with centre of eye. Snout blunt, broad and rounded, lips fleshy. Usually five pores in the supramaxillary series (very occasionally 6 or 4) the rest of the head pores as usual in *Galaxias* spp. (see Figure 3).

Dorsal and anal fins moderate in size with dorsal fins inserted about level or slightly in advance of anal fin origin. Paired fins of moderate size with pectorals inserted almost horizontally and very low in body profile. Very little fleshy thickening of the bases of any fins. Caudal peduncle deep, anal fin when adpressed covering part of caudal keel. Caudal fin only slightly indented.

Gill rakers short and blunt, 12 - 15 on first arch. Strongly developed lateral canine teeth in both upper and lower jaws, pyloric caeca absent.

Variation

For morphometric and meristic variation see Tables 1 and 2 respectively.

Colour

In life, light olive-green on back lightening down the sides to silver-white on the ventral surface. Sides and back are speckled with a light brown colour which may form fragmented bars or patches. In preservative, the fish are light grey in colour with darker grey speckled patches or broken bars on the back and sides with a pale grey to white ventral surface. There is little colouration in the fins in life or in preservative.

Size

The largest specimen yet seen measured 96 mm TL but most of the specimens examined were between 60 and 80 mm TL.

Life History

There has not been a detailed study of the life history of this species or any other endemic galaxiid in Tasmania. However, *G. fontanus* appears to be the only endemic Tasmanian member of the genus to be confined to a riverine environment. It probably passes its entire life in the river, as indicated by the presence of juvenile specimens (about 20 mm TL) at the type locality.

It therefore appears that spawning may take place at or near the normal adult habitat and that *G. fontanus* probably lacks the marine juvenile phase exhibited by the river-dwelling populations of other Tasmanian species, *G. brevipinnis* Gunther, *G. maculatus* Jenyns and *G. truttaceus* Valenciennes.

There was little development of the gonads of specimens collected in January 1976 or February 1978. However, eggs were visible in April 1978 specimens but the ovaries were not nearly fully developed. Hence it appears that spawning may not take place until late winter or spring.

Distribution

Specimens have been collected only from the upper reaches of the Swan River in the eastern part of Tasmania (see Figure 4). It may be present in some other branches of this river but was not found in any other nearby river systems or larger tributaries of the Swan River.

The short-finned eel, *Anguilla australis* Richardson, is also present at the collection site but the brown trout, *Salmo trutta* Linnaeus, although in most other nearby streams, was not collected with *G. fontanus*.

DISCUSSION

The new species appears most similar morphologically to *G. brevipinnis* in Tasmania or to *G. olidus* of mainland Australia but differences from both of these forms and other similar Tasmanian species as outlined earlier in the diagnosis are sufficient to justify its recognition as a distinct species.

The question of its origin is more difficult to explain as the species is amidst a virtual 'desert' as far as native fish are concerned. The east coast of Tasmania is the driest part of the state and most of its rivers have had periodic dry spells in recent times. Furthermore, brown trout are well established in most of the streams and they have been found to be

incompatible with galaxiid species of this type (Jackson 1975, Tilzey 1977). However, it appears that the Swan River system must have survived any droughts and access by trout has probably been prevented by the presence of Hardings Falls, approximately three kilometres downstream from the type locality on the Swan River, thus allowing the evolution and survival of *G. fontanus* in a virtually landlocked locality.

ACKNOWLEDGEMENTS

I wish to thank Mr. R. Mawbey, Zoology Department, University of Tasmania, and Dr. R. McDowall, Fisheries Research Division, Wellington, New Zealand, for assistance with the collection of specimens. I am also grateful to Dr. McDowall and to Mr. D. D. Lynch, Inland Fisheries Commission, Tasmania, for reading the manuscript.

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TABLE 1 Morphometric variation in 30 *G. fontanus*. Values are percentages of standard length (SL) or head length (HL).

	Holotype	Range	Mean	S.D.
Length to caudal fork/SL	115.1	112.1 - 117.6	115.48	1.09
Total length/SL	117.4	115.5 - 120.4	117.67	1.20
Body depth at vent/SL	15.0	12.6 - 15.4	14.17	0.66
Depth caudal peduncle/SL	10.6	9.4 - 10.8	10.03	0.46
Length caudal peduncle/SL	15.3	14.4 - 17.8	15.68	0.94
Length dorsal fin base/SL	11.9	9.3 - 12.6	10.92	0.08
Maximum length dorsal fin/SL	17.9	16.8 - 20.1	18.23	0.82
Length anal fin base/SL	15.3	13.0 - 16.9	14.85	0.87
Maximum length anal fin/SL	20.0	18.4 - 22.9	20.40	1.06
Pectoral fin length/SL	15.1	14.0 - 17.8	16.03	0.96
Pelvic fin length/SL	14.1	12.7 - 16.0	14.32	0.75
Pre-dorsal length/SL	73.2	70.4 - 74.4	71.89	1.00
Pre-anal length/SL	73.4	70.7 - 73.9	72.37	0.96
Pre-pelvic length/SL	50.4	49.5 - 53.9	51.24	1.04
Pectoral-pelvic length/SL	28.1	27.5 - 30.8	29.16	0.98
Pelvic-anal length/SL	22.2	19.4 - 24.0	21.30	1.05
Head length/SL	25.3	23.0 - 26.3	24.75	0.92
Head width/HL	60.5	56.5 - 66.7	60.24	2.36
Head depth/HL	51.5	48.0 - 61.9	53.05	2.80
Snout length/HL	31.7	26.6 - 36.2	31.58	2.55
Post-orbital head length/HL	50.3	46.0 - 53.8	50.53	1.97
Inter-orbital width/HL	44.3	41.0 - 51.9	45.13	2.36
Eye diameter/HL	23.9	22.0 - 28.5	25.15	1.75
Length of upper jaw/HL	44.9	41.1 - 47.2	44.30	1.59
Length of lower jaw/HL	43.1	37.3 - 45.5	42.51	1.99
Width of gape/HL	38.2	37.0 - 45.5	40.41	1.81

TABLE 2 Meristic variation in *G. fontanus*. Values expressed are frequencies. An asterisk (*) denotes the value for the holotype.

	6	7	8	9	10	11	12	13	14	15	16	17	50	51	52	53
Dorsal fin rays		3	*22	5												
Caudal fin rays										3	*26	1				
Anal fin rays			1	2	17	*9	1									
Pectoral fin rays			1	18	10	*10										
Pelvic fin rays	1	*28	1													
Gill rakers						*8	11	3	5	3						
Vertebrae													1	9	8	2

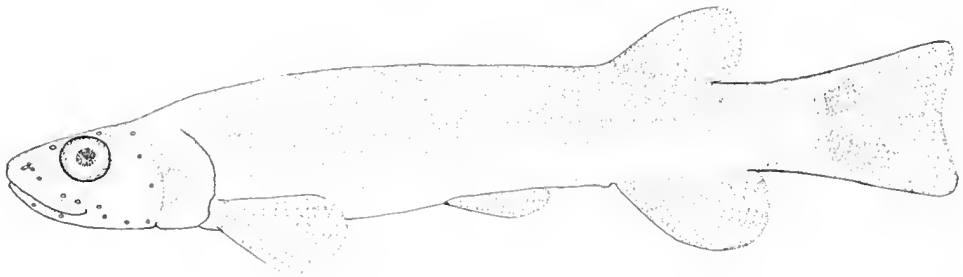
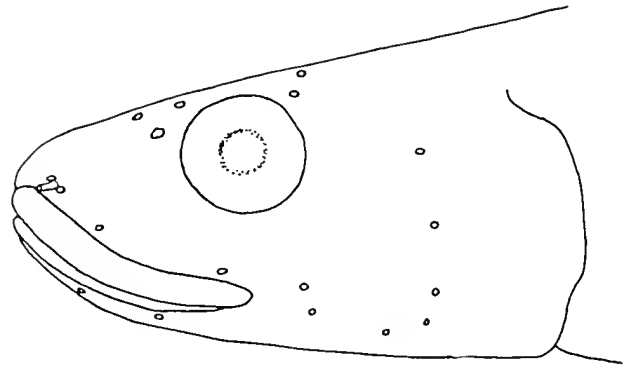
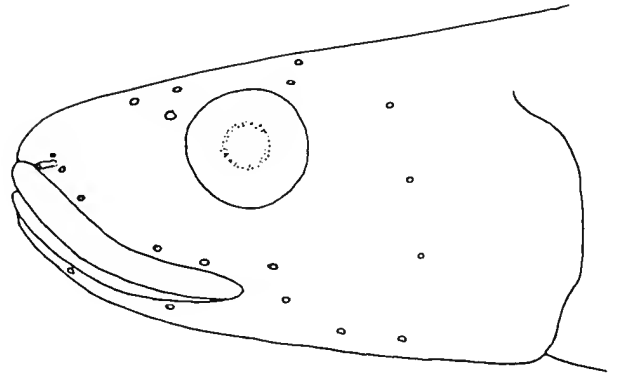


FIGURE 1 *Galaxias fontanus* sp. nov. holotype, Swan River, 78 mm TL.

FIGURE 2 *Galaxias fontanus* sp. nov. in life.



(A)



(B)

FIGURE 3 Distribution of laterosensory pores in (A) generalised galaxiid (B) *G. fontanus*.

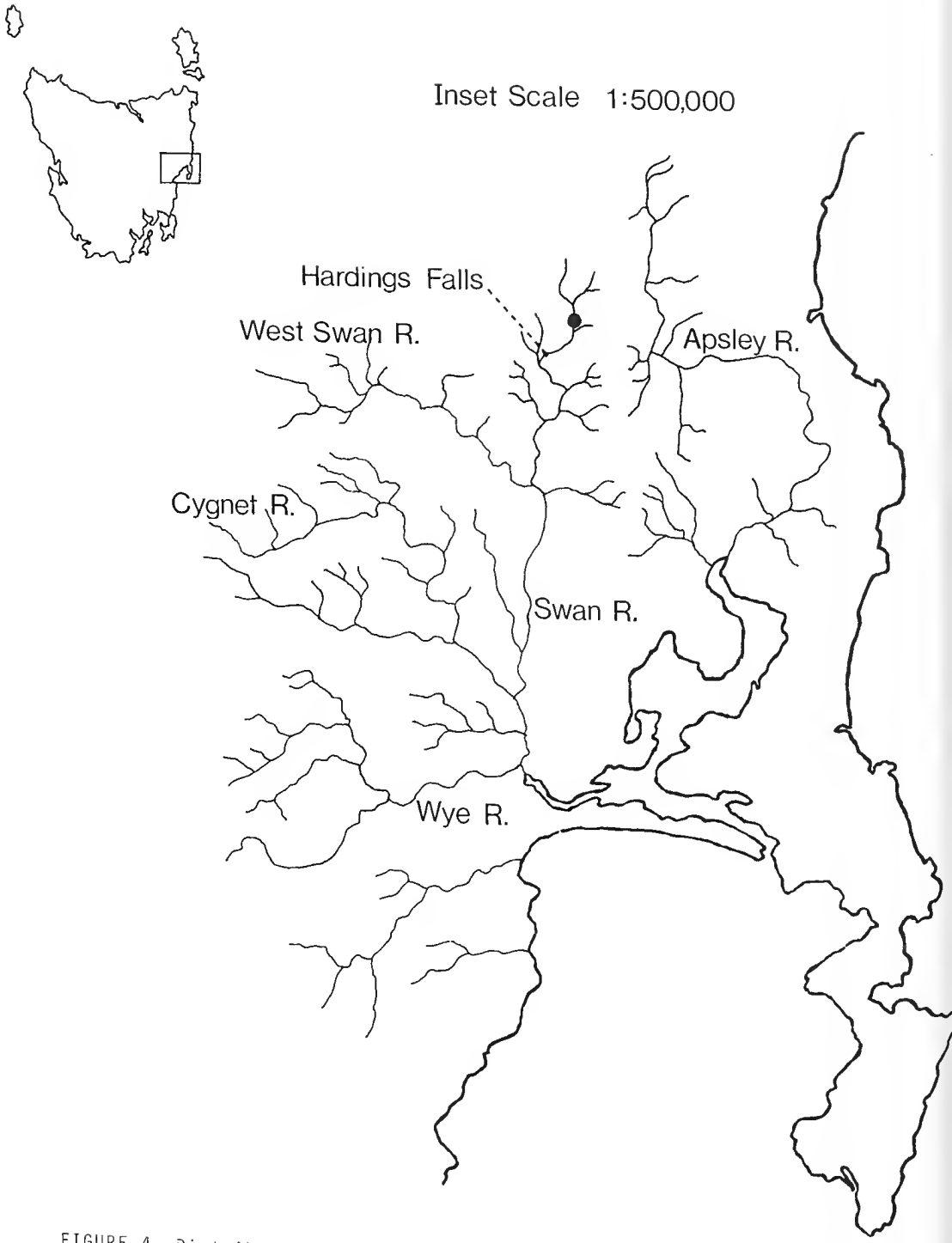


FIGURE 4 Distribution of *G. fontanus* in Tasmania. (Only site indicated by ●.)

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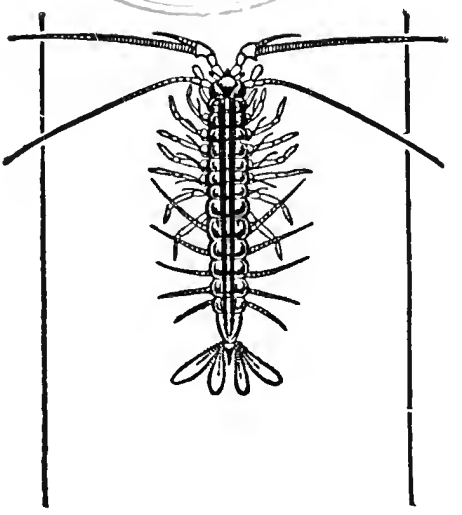
RECORDS OF THE QUEEN VICTORIA MUSEUM LAUNCESTON



Edited by
C. B. TASSELL
Director of the Museum

SOME AQUATIC OLIGOCHAETA FROM TASMANIA

by

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ABSTRACT

Ten new species of aquatic oligochaetes are described from Tasmania. The species are all in the families Tubificidae (four species), or Phreodrilidae (six species). Nine other species already described are shown to be present in the State thus bringing to nineteen the total number of oligochaete species positively identified from Tasmania.

INTRODUCTION

The aquatic oligochaete fauna of Tasmania was unknown prior to the discovery of the three tubificids *Telmatodrilus multiprostatus*, *T. pectinatus* and *Antipodrilus davidis* and the cosmopolitan *Lumbriculus variegatus* by Brinkhurst (1971). More recently Timms (1978) has established the presence of five other species (*Phreodrilus branchiatus, P. mauienensis, Tubifex tubifex, Limnodrilus hoffmeisteri* and *L. udekemianus*). Material now available from the South Esk River, Great Lake, and some other lakes, collected by the junior author, Mr. R. H. Norris and Dr. B. V. Timms, has confirmed the presence of two of these and uncovered ten species new to science, giving a total of nineteen known Tasmanian forms. This new material has made possible the identification of some of the forms previously recorded from Tasmania but not described for lack of adequate material (Brinkhurst, 1971, p. 110), but several species remain to be described.

The descriptions are brief but are adequate for the identification of the species concerned. In some instances, there was enough material to permit serial sections to be made as noted in the text, sometimes there was not. More detailed studies should be made but are beyond the scope of this initial report.

All specimens used in the study were collected by the junior author (unless otherwise stated in the text) from Great Lake, Tasmania, at various dates throughout 1975. Type material of the new species as well as specimens of some of the other species discussed has been deposited in the Quen Victoria Musum, Launceston (QVM). This abbreviation appears in the text with the type or deposit number for the material.

Family TUBIFICIDAE

Genus *Limnodrilus* Claparede, 1862

Limnodrilus hoffmeisteri Claparede, 1862

This cosmopolitan species was found in small numbers in Brandum Bay, Great Lake. It was first recorded, along with *L. udekemianus*, by Timms (1978) who also reported the cosmopolitan *Tubifex tubifex*.

Genus *Antipodrilus* Brinkhurst, 1971

Antipodrilus plectilus sp. nov.

Figures 1-5

Description : Small thin red worms up to 40 mm extended. Dorsal and ventral anterior bundles of setae with 7 to 8 or 9 setae, reducing in number to 3 per bundle and eventually to only 4 per segment posteriorly. Setae of II with upper tooth shorter and thinner than the lower, setae of other pre-clitellar bundles with teeth equally long, upper slightly thinner if not equal in width; posteriorly upper teeth shorter and thinner. Spermathecal setae single, thin, hollow-tipped, lying in glandular sacs. Atria elongate, distended where vasa deferentia and prostate glands are attached; ejaculatory ducts moderately long, penes simple without cuticular sheaths. Spermatozeugmata elongate, one end thin. Other characteristics as for the family.

Material : Collected from Swan Bay, Cramps Bay and Brandum Bay in Great Lake. Seven specimens examined, four mature.

Holotype, 1977/14/6 — QVM type 242.

Paratypes, 1977/14/1-5, 7 — QVM types 258-263.

Discussion : *A. plectilus* is found in clusters of up to about fifty specimens where abundant, most often in fine silts with more than 50% by weight below 4.0 ϕ units.

The distinction between this and other species in the genus will be discussed below.

Antipodrilus multiseta sp. nov.

Figures 6-8

Description : Large worms, up to 50 mm long. Red-pink in colour, covered by a sheath of small sand grains. Anterior end tapering to coiled tail. Dorsal and ventral anterior bundles of II with 12-15 setae, gradually diminishing in number to 3-4 posteriorly. Anterior setae bifid with blunt teeth of equal thickness, the upper slightly longer. Posterior setae with upper teeth shorter than the lower. Spermathecal setae single, thin, hollow-tipped, apparently in glandular sacs. Atria small, vasa deferentia moderately long, ejaculatory ducts long and thin, prostate glands small, penes simple, no cuticular sheaths. Spermathecae voluminous, spermatozeugmata elongate. Other characteristics as for the family.

Material : Collected from Cramps Bay and Brandum Bay in Great Lake. Five specimens examined.

Holotype, 1977/14/8 — QVM type 243.

Paratypes, 1977/14/9-10, 110 — QVM types 264-265, 354.

Discussion : The type species *A. davidis* (Benham) and the only other species *A. timmsi* Br., have hair-setae which are lacking in both new species. Otherwise the new species share many of the characteristics of the genus, but differ from each other in the number and form of the setae and the length of the ejaculatory ducts.

The genus is limited to Australia and New Zealand.

Genus *Telmatodrilus* Eisen, 1879

Telmatodrilus (Alexandrovia) papillatus sp. nov.

Figures 9-14

Description : Worms encrusted with foreign particles. Pharynx eversible. Body wall papillate, large papillae in rings halfway between successive seta bundles, rings of smaller papillae halfway between each seta series and the ring of larger papillae. Anterior setae bifid, 5-7 per bundle with each tooth broad, shovel-shaped, gradually becoming hair-like until post-clitellar segments with 5-9 hair setae in dorsal and ventral bundles. Penial setae 3-4 per bundle, with bifid tips. Male pore median, two short atria enter median chamber close together. At least 2 or 3 prostate glands on atria apically. Prominent tubercle on IX.

Material : Collected from Brandum Bay in Great Lake and also from Lake Sorell (B. V. Timms). Seven specimens examined, one mature.

Holotype, 1977/14/11-12 — QVM types 244-245.

Paratypes, 1977/14/94-99 — QVM types 338-343.

Discussion : The genus *Telmatodrilus* originally consisted of the two poorly described Californian species, *T. vejdovskyi* and *T. mcgregori*. Fresh specimens were obtained by the senior author in 1966 and were identified as *T. vejdovskyi*, the second species having early been regarded as a synonym of this species (Brinkhurst, 1965). Two multi-prostate species were described from Lake Pedder, Tasmania, as *T. pectinatus* and *T. multiprostatus* by Brinkhurst (1971). The former has since been recorded from Lake Tali Karng, Victoria, Australia (Timms, 1974) and the latter has been identified by the senior author from material collected in the South Esk River, Lake Sorell and Lake Crescent in Tasmania. *Telmatodrilus pectinatus* was thought to be the only tubificid having the pectinate setae limited to posterior segments rather than the anterior dorsal segments, but Holmquist (1974) recognised an oversight in the earlier descriptions of the Californian species, which also proves to have pectinate (or rather brush-tipped) posterior setae. That author, however, recognised the rediscovered Californian material as *T. mcgregori* rather than *T. vejdovskyi*, and considered the Tasmanian species to be excluded from *Telmatodrilus* but did not assign them to a taxon other than the (monogeneric) subfamily Telmatodrilinae. She also preferred to see the other multiprostate species *T. onegensis* and *T. ringulatus* remain in the genus *Alexandrovia*, proposed by Hrabe (1962) for the former, which he found in Onega Lake (located between the Gulf of Finland and the White Sea in European Russia). Holmquist expanded the description of this genotype from Alaskan material. These two species are papillate, as is the new species found in Tasmania, and hence this new form is assigned to *Alexandrovia*, but that taxon is regarded as a subgenus pending clarification of the various points of difference between it and *Telmatodrilus*. Spermatozeugmata have been recorded in both *Alexandrovia* species, but the newly described specimen seems to lack spermathecae. There are no spermatozeugmata in *T. vejdovskyi* (as *mcgregori* acc. Holmquist).

The latest member of the assemblage *T. papillatus* is instantly recognisable by its extraordinary setae, in which bifid setae with shovel-like teeth become transformed into hair-like setae in all bundles. This characteristic alone might be regarded by some as sufficient grounds for the erection of a new genus, but the senior author prefers the conservative position of retaining one generic name for all these multi-prostate species in order to signal this unique similarity, at least until they are all subject to more detailed examination.

Telmatodrilus (Telmatodrilus) multiprostatus Brinkhurst 1971

Two mature specimens from the South Esk River (R. H. Norris coll.). Also Lake Sorell and Lake Crescent (B. V. Timms).

1977/14/100-101.

Telmatodrilus? (Telmatodrilus?) bifidus sp. nov.

Figures 15-19

Small pink worms, up to 25 mm long, generally uniform in thickness but narrowing posteriorly. Setae bifid, anteriorly up to 13 per bundle with upper tooth longer than but thinner than the broad lower. Posteriorly setae progressively fewer in number, upper tooth thinner and shorter than lower from VIII or X, setae strongly sigmoid posteriorly. Some of the setae appear to be ornamented (figure 15). Spermathecal setae single straight, thin, hollow-tipped, varying in length from shorter than to three times longer than the normal ventrals. Penial setae bifid, straight, twice as long and thick as ventral setae, 6-7 per bundle. Spermathecae small, bilobed with short duct-like extension; pores lateral. Spermatozeugmata short. Atria small, spherical bodies on short, straight stems; vasa deferentia short. No cuticular penis sheaths. Prostate glands bilobed, extending around the vasa deferentia anteriorly but with a posterior lobe, precise attachment to atria not discerned. Male pores and penial setae open into large median depression.

Material : Collected from a depth of about 15 m in Swan Bay, Brandum Bay and Cramps Bay in Great Lake. Five mature specimens dissected, two sectioned, three immature sectioned.

Holotype, 1977/14/13 — QVM type 246.

Paratypes, 1977/14/14-24 — QVM types 266-276.

Discussion : This species is assigned to *Telmatodrilus* with some degree of uncertainty, which will only be clarified by examining the precise association between the prostate glands and atria. The prostates are at least bilobed, but whether they connect to the atria by one broad connection or two or more connections, cannot be discerned from dissections or sections of the first series of specimens.

The relatively large number of setae, presence of both modified spermathecal and moderately modified penial setae, presence of an eversible pseudopenis and absence of coelomocytes together with the short, rounded atrial form agree quite closely with another Tasmanian species, *Telmatodrilus pectinatus*, described from Lake Pedder (Brinkhurst, 1971). The prostates were quite clearly seen in that species, and the setae were assigned to their appropriate locations. Holmquist (1974) found the specimens to be in a poor condition, and the same is true of those still in the senior author's possession. For some reason, the mounting medium beneath the sealed-on cover glass has disappeared, forming large bubbles. The gut of those specimens was full of large coarse sand grains, so much so that the preparations are unusually thick, and sections could not be prepared without obtaining live material and starving them which was not feasible. Holmquist pointed out that the number of prostates, their position on the atria, and the form of atria in the Tasmanian species are quite different to those found in *T. vejdovskyi/mcgregori*, as is the lack of a true penis. She proposed to exclude them from both *Telmatodrilus* and *Alexandrovia* to retain them in the subfamily, but declined to erect a new genus until more adequate material is available. Her proposals are supported by the similarities between members of this assemblage including the primary character, numerous prostates, and some other minor points, such as a rather large number of setae. There are differences, just as there are within the monogeneric family *Phreodrilidae* (genus *Phreodrilus*) as described below, but it would seem more convenient, given our state of knowledge, to emphasise the similarity rather than the differences until more is known. The only decision to make is the level at which the similarity is recognised.

However, this latest form quite clearly has spermatozeugmata in the spermathecae, which are absent in *T. vejdovskyi*, but present in *T. (A.) onegensis* and *T. (A.) ringulatus*. Holmquist (1974) seemed certain that the sperm are in bundles in *T. multiprostatus* and *T. pectinatus* after examining the poorly preserved slides of the senior author's dissections. The senior author is less certain as to the presence or absence of spermatozeugmata in them.

Family PHREODRILIDAE

Genus *Phreodrilus* Beddard, 1891

Phreodrilus (Phreodriloides?) plumaseta sp. nov.

Figures 23-27

Description : Dimensions unknown. Ventral setae two per bundle, bifid with upper tooth shorter and thinner than lower, those of XII missing, those of XIII paired spermathecal setae, one long and one short, hollow-ended. Dorsal setae from III single brush-tipped broad setae with paired short needles. Atria elongate, tubular vasa deferentia joining basally, apparently no penes.

Material : Collected from a depth of about 15 m from Cramps Bay and Brandum Bay in Great Lake.

Holotype, 1977/14/36 — QVM type 249.

Paratypes, 1977/14/37, 107-109 — QVM types 286-293, 351-353.

Discussion : Insufficient details are available to place this species in a subgenus, though the choice is clearly between the group *Pheodriloides* (without penes, without ampullae on spermathecal pores), and *Insulodrilus* (with ampullae, with penes), both of which have ventral genital openings. However the species is quite distinct from the members of both subgenera. Only *P. magnaseta* (below) has similar dorsal setae, but it has very distinctive ventral setae. *P. nudus* (below) has similar ventral setae but lacks the plumed hair setae, and is clearly an *Insulodrilus*. The limited amount of material available has prevented further investigation of the genital pores, the presumption at present being that they are simple, lacking ampullae or penes.

Phreodrilus (Insulodrilus) nudas sp. nov.

Figures 20-22

Description : Dorsal setae from III single, broad based and narrowing abruptly, nonserrate. Ventral setae paired, bifid, lower tooth broader than the upper, both teeth short and blunt. Spermathecal setae long, paired, with hollow tips. Genital pore in line ventro-laterally, spermathecal pores with well-developed vestibulae, penis sacs with elongate penes. Spermathecal setae enclosed in glandular sacs. Spermathecal ampullae at the end of elongate ducts. Atria long, cylindrical.

Material : Collected from the South Esk River (R. H. Norris coll.), Lake Pedder, March 1966 (W. D. Williams coll.). Five specimens examined.

Holotype, 1977/14/90 — QVM type 252.

Paratypes, 1977/14/91-93 — QVM types 335-337.

Discussion : This species is very similar to the following species, but differs primarily in the absence of serrations on the hair setae. Of the other species in the subgenus, *P. lacustris* has rudimentary vestibulae, *P. campbellianus* has no spermathecal setae, *P. litoralis* has one, and all three have dissimilar ventral setae (one simple pointed, one bifid in each pair).

Phreodrilus (Insulodrilus) magnaseta sp. nov.

Figures 28-32

Description : Dimensions unknown. Ventral setae two per bundle, simple pointed, becoming progressively larger from II to VIII, smaller from VII on, simple pointed or with reduced upper tooth. No ventral setae on XII. Spermathecal setae on XIII two per bundle, one very much longer and thinner than the other, both hollow-tipped. Dorsal setae from III, hair-like with brush tips, becoming hairy in succeeding segments, but becoming shorter and blunter behind the clitellum, one per bundle with two short lateral needles. Vasa deferentia enter long cylindrical atria basally, penes in cuticularised sacs, spermathecal pores with small vestibulae and setal sacs in line with penis sacs. Other characters as for the family.

Material : Collected from a depth of about 15 m from Swan Bay and Cramps Bay in Great Lake. Seven specimens examined.

Holotype, 1977/14/31-32 — QVM type 247-8.

Paratypes, 1977/14/25-30, 33-35 — QVM types 277-285.

Discussion : The ventral setae of this species are unique in the family, being reminiscent only of those described for *Haplotaxis gastrochaetus* (Yam.) from Japan (Yamaguchi, 1953), but in the latter the setae become larger up to the twentieth segment rather than the seventh. The dorsal setae resemble those of *P. plumaseta* (q.v.).

Phreodrilus (Insulodrilus) breviatria sp. nov.

Figures 33-36

Description : Dimensions unknown. Ventral setae clearly bifid with thin, short upper teeth. No spermathecal setae. Hair setae with needles dorsally, (3) 4-5 (6) per bundle, distinct and thick from III on, bent, tapering beyond the bend, 13-16 setae medially. Vasa deferentia join atria submedially, atria short thick cylinders, penes small in large penis sacs. Spermathecal pores close to male pores, with small vestibulae.

Material : Collected from a depth of about 15 m from Cramps Bay and Brandum Bay in Great Lake. Four mature, six immature specimens examined.

Holotype, 1977/14/45 — QVM type 250.

Paratypes, 1977/14/46-49 — QVM types 294-297.

Discussion : The atria are short and thick in this species, and consequently the near-basal position of the vasa deferentia appears to be more medial than in other species in the sub-genus. The species has bifid ventral setae in each pair, no spermathecal setae, and small vestibulae on the spermathecal pores. It does not have plumed setae nor enlarged ventrals, and so is distinguishable from the other species in the sub-genus.

Phreodrilus (Phreodrilus) branchiatus Beddard, 1891

Figures 37-38

Description : Dorsal setae from III, 1-3 long thin straight hair setae, two short needles on each side of each hair basally, often a third short hair seta. Ventral setae one thin simple pointed seta and one broad bifid seta with short, thin upper tooth in each bundle. Sixteen to fifty pairs of dorso-lateral gills posteriorly.

Material : Collected from Brandum Bay in Great Lake and from the South Esk River (R. H. Norris coll.).

Five specimens examined. 1977/14/102-106.

Discussion : The original locality for this species is in Southern Chile. It was only briefly described, but the Tasmanian material fits the description apart from a larger number of gills (from 16 in the smallest to 50 in largest specimen as opposed to 13 in the type material). Timms (1978) recorded the species from Tasmania.

Phreodrilus (Phreodrilus) palustris sp. nov.

Figures 39-43

Description : Length 10-40 mm, up to 2 mm thick. Light brown worms, in two size classes in the collection. Ventral setae 2 per bundle, both more or less blunt with a rudimentary upper tooth. Dorsal setae anteriorly thin hair-setae, progressively increasing in number and size posteriorly from 1 or 2 to 5-8 and eventually up to 19 setae a bundle, with short needles between the hairs, the setae bent, narrowing abruptly beyond the bend, dorsal setae diminish in size and number at posterior end. No modified genital setae. Vasa deferentia strongly coiled, long with thin portion proximally, thicker portion distally, joining atria at or near elaborate eversible pseudopenes. Atria moderately long, thick. Spermathecae with sperm traps in ducts, reach to 7 segments behind pores, which are dorsal with muscular vestibulae. Swims quite rapidly with a spiral motion.

Material : Collected from Swan Bay, Cramps Bay and Brandum Bay in Great Lake. Six mature specimens, three sectioned, seven immature examined.

Holotype, 1977/14/54 — QVM type 251.

Paratypes, 1977/14/51-53, 55-79 — QVM types 298-325.

Discussion : This species is, at first sight, rather similar to *P. breviatria*. In all specimens examined to date the anterior end of *P. palustris* has few, thin hair-setae and each segment has about the same diameter as the next. In *P. breviatria* the hair-setae are larger, more obvious right from III. there are more setae in III. and the anterior end is tapering because the segments increase in diameter quite abruptly. The male ducts are quite clearly different also, with true penes in *P. breviatria*, the two species therefore belonging to separate sub genera. The two ventral setae of each bundle are alike in *P. palustris*, whereas in the other species in the same subgenus they ar dissimilar. Also, there are more hair-setae per bundle in this species than in others in the subgenus, especially in the median segments.

Phreodrilus proboscidea sp. nov.

Figures 44-46

Description : Prostomium with a proboscis. Dorsal setae from III, 2-4 serrate hair-setae, long, thin and straight, numerous shorter needles, usually one each side of each hair-seta. Ventral setae of III and IV simple pointed, one thicker than the other, from V on one bifid with short thin upper tooth, one thinner simple pointed.

Material : Collected from Cramps Bay in Great Lake and also from Lake Pedder, March 1966 (W. D. Williams). Ten whole mounts.

Holotype, 1977/14/80 — QVM type 253.

Paratypes, 1977/14/81-89 — QVM types 326-334.

Discussion : Some fragmentary specimens of a phreodrilid with a proboscis and serrate hair-setae were found in the Lake Pedder collection (Brinkhurst, 1971, p. 110) but no name had been given to the species. The above description is clearly provisional, but will suffice to distinguish this species from all others unless further research turns up two with this combination of characters. The species cannot be assigned to a subgenus pending description of the reproductive system. The definition of the family requires changing as a result of these descriptions.

Similar specimens with a proboscis and the bamboo-like serrate hair setae were sent to the senior author from a trickle beside Guthries Creek, Mt. Kosciusko, New South Wales, collected 9.1.74 by H. B. N. Hynes.

Family HAPLOTAXIDAE

Several specimens, apparently assignable to at least two species in this family, were found in Great Lake but could not be described for lack of mature specimens.

Family LUMBRICULIDAE

One immature form resembling *Lumbriculus variegatus* was observed in the South Esk River. This species has been recorded in Tasmania, and is the only cosmopolitan form in the holarctic family.

DISCUSSION

According to earlier records (Brinkhurst, 1971) the only aquatic oligochaete species known from Tasmania were *Lumbriculus variegatus, Antipodrilus davidis* and two new species of *Telmatodrilus* from Lake Pedder (*T. multiprostatus* and *T. pectinatus*). A preliminary inspection of a collection on loan from B. V. Timms established the presence of one of these (*T. multiprostatus*) in two Tasmanian lakes, together with the cosmopolitan *Limnodrilus hoffmeisteri* in a third. This collection was subsequently investigated in more detail by Dr. K. V. Naidu who found *Tubifex tubifex, Limnodrilus udekemianus,* both the new *Telmatodrilus* species and *Phreodrilus branchiatus* together with some unnamed species (Timms, 1978).

The present collection contains ten new species plus *P. branchiatus* and *Limnodrilus hoffmeisteri*. The absence of other known Australian species and the presence of so many new species further emphasises the unique nature of the Tasmanian aquatic oligochaete fauna. Of the known Tasmanian species *P. branchiatus* is known only from Chile, *L. hoffmeisteri, L. udekemianus* and *L. variegatus* are cosmopolitan, *T. pectinatus* is known from the Australian mainland and *A. davidis* from the Australian mainland and New Zealand, leaving eleven species which may be endemic to the island.

Likewise a difference between Tasmanian and Australian mainland faunas has been noted in the stonefly group. Hynes (1976) found that only six out of a total of sixty-six stonefly species can be found on both sides of Bass Strait according to the most conservative count. However, the genera are often shared, both in the oligochaetes and stoneflies.

The generic limits in the oligochaeta may yet be revised, especially in the monotypic "Gondwanaland" family Phreodrilidae.

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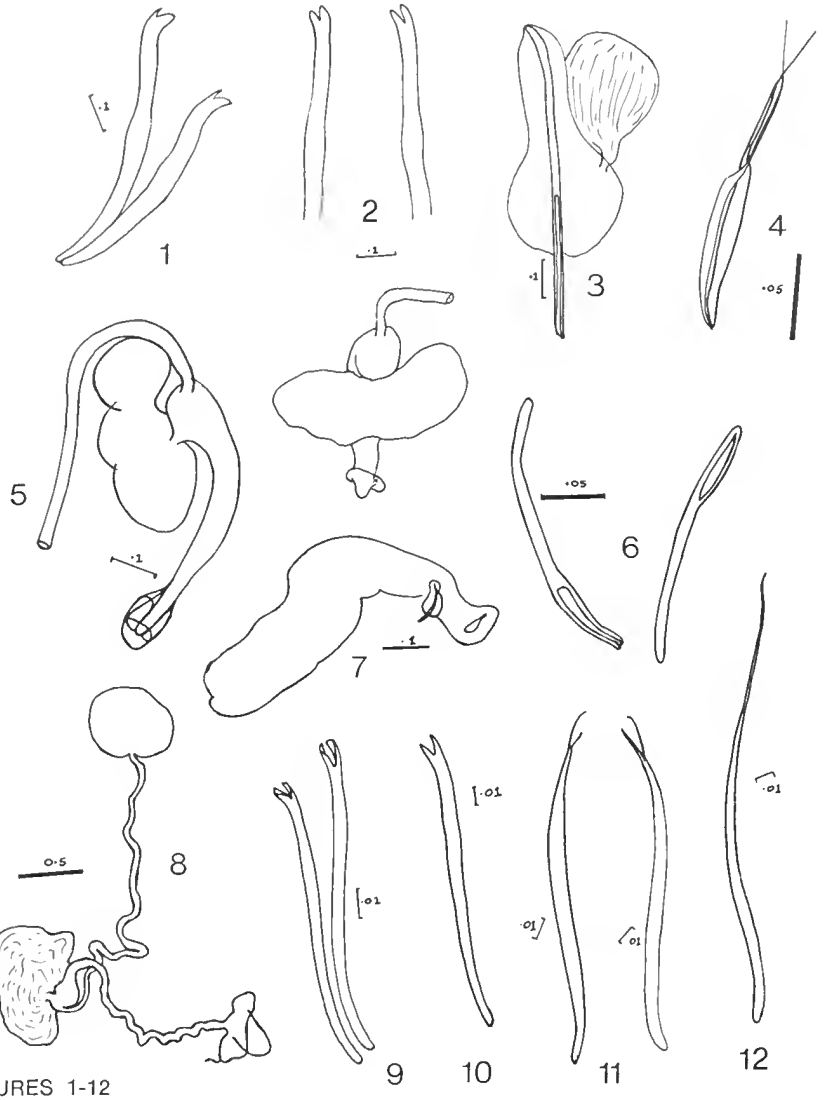


FIGURES 1-12

Figures 1-5 *Antipodrilus plectilus* sp. nov.

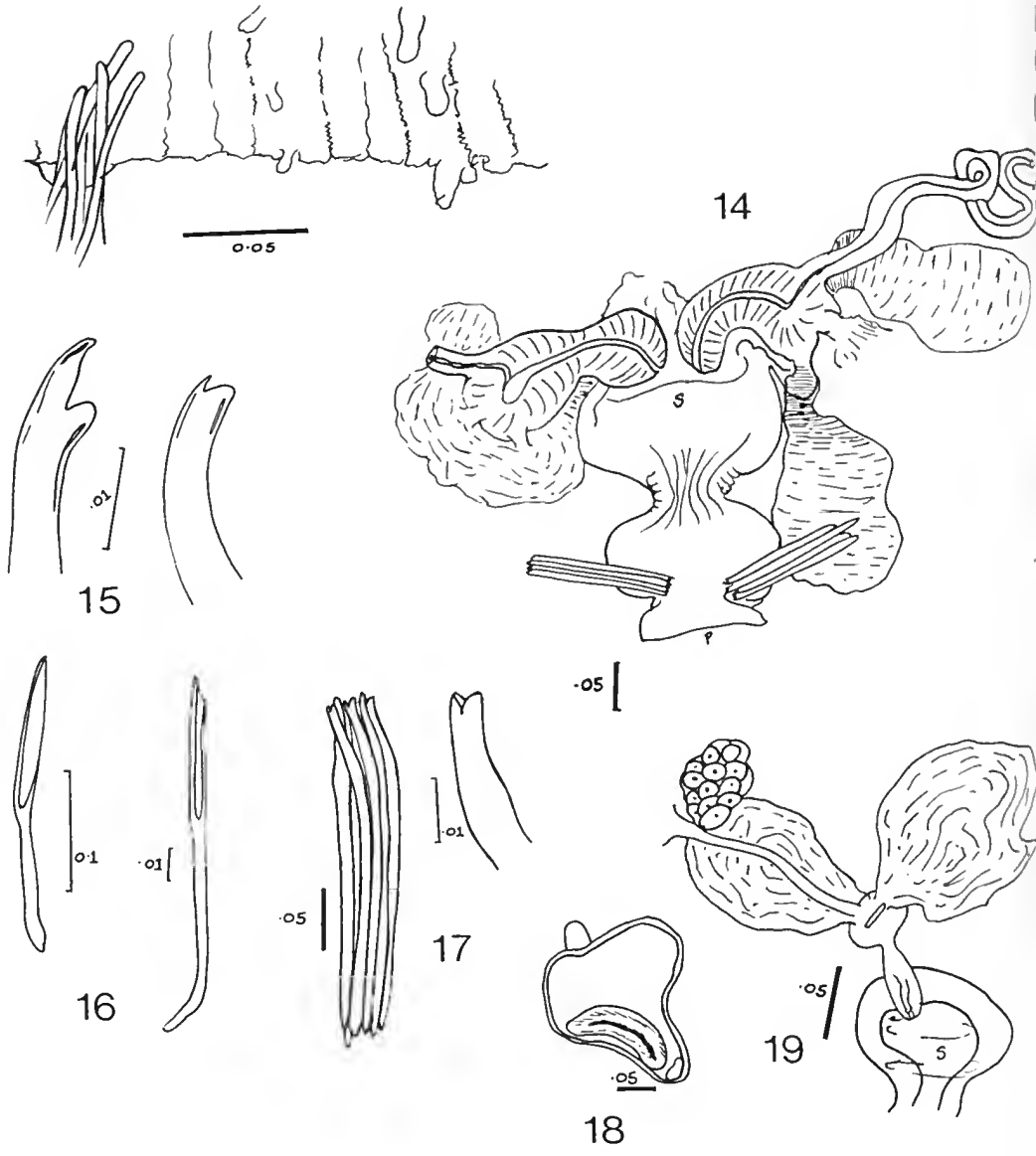
1. Setae of II.
2. Setae of VII.
3. Spermathecal seta in sac with glands.
4. Two spermatozeugmata.
5. Atria, prostates, vasa deferentia and ejaculatory ducts.

Figures 6-8 *Antipodrilus multiseta* sp. nov.

6. Spermathecal setae.
7. Spermatheca and spermathecal seta.
8. Male efferent duct — sperm funnel at top, penis on lower right.

Figures 9-12 *Telmatodrilus papillatus* sp. nov.

9. Ventral setae of IV.
10. Setae of VIII.
11. Setae of XI-XIII.
12. Posterior seta.



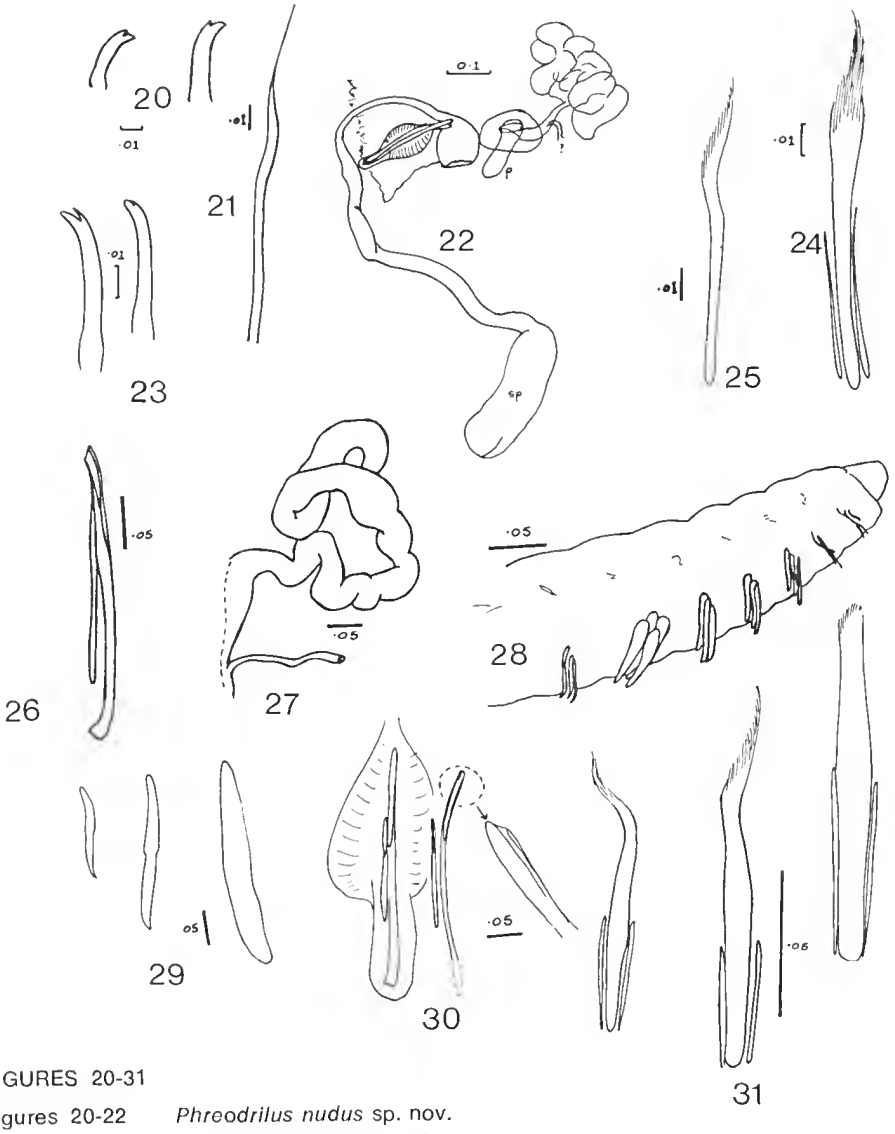
FIGURES 13-19

Figures 13-14 *Telmatodrilus papillatus* sp. nov. (cont.)

13. Body wall showing papillae.
14. Male efferent ducts — two atria with prostates (attachment not certain) entering common median sac(s) to median pore (p) with penial setae.

Figures 15-19 *Telmatodrilus bifidus* sp. nov.

15. Setae, anterior and median.
16. Spermathecal setae (note two sizes).
17. Penial setae.
18. Spermatheca with spermatozeugmata.
19. Vas deferens, ovary, prostate (attachment uncertain), atrium and median sac(s).



FIGURES 20-31

Figures 20-22 *Phreodrilus nudus* sp. nov.

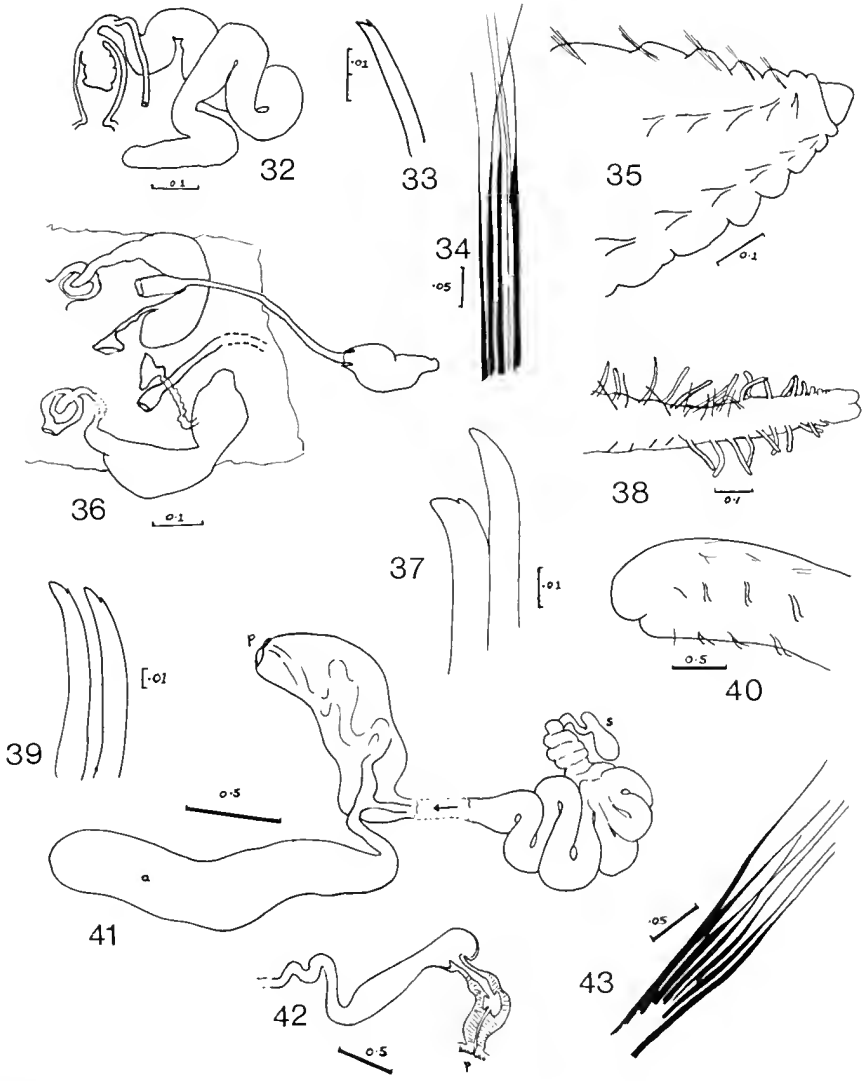
20. Ventral setae of III, VII.
21. Dorsal seta.
22. Reproductive system: spermathecal ampulla (sp) with long duct, vestibulae anterior to spermathecal seta; penis (p) and coiled atrium.

Figures 23-27 *Phreodrilus plumaseta* sp. nov.

23. Anterior ventral setae.
24. Anterior dorsal seta.
25. Median dorsal seta.
26. Spermathecal seta.
27. Male duct.

Figures 28-31 *Phreodrilus magnaseta* sp. nov.

28. Anterior end showing progressive enlargement of ventral setae.
29. Ventral setae of II, V, VI (from left to right).
30. Spermathecal setae in sac, detail of tip.
31. Dorsal seta of II, VIII, XV (from left to right).



FIGURES 32-43

Figure 32 — *Phreodrilus magnaseta* sp. nov. (cont.)

32. Male efferent duct.

Figures 33-36 — *Phreodrilus breviatria* sp. nov.

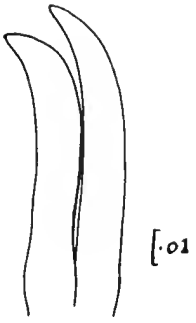
33. Ventral seta.
34. Dorsal setae.
35. Prostomium and conical anterior end.
36. Male efferent ducts and spermathecae.

Figures 37-38 — *Phreodrilus branchiatus*

37. Ventral setae.
38. Posterior end with gills.

Figures 39-43 — *Phreodrilus palustris* sp. nov.

39. Ventral setae.
40. Anterior end — not tapering, conical (c.f. 35).
41. Male efferent duct: male pore (p), sperm funnel (s), and atrium (a).
42. Spermathecal pore (p), sperm trap, spermathecal duct leading to ampulla.
43. Dorsal setae.



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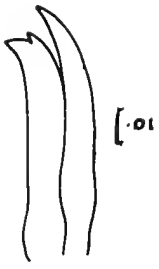

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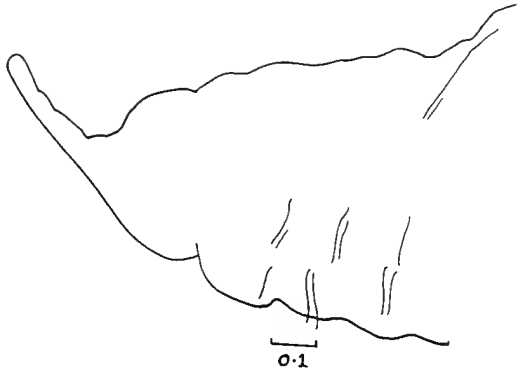

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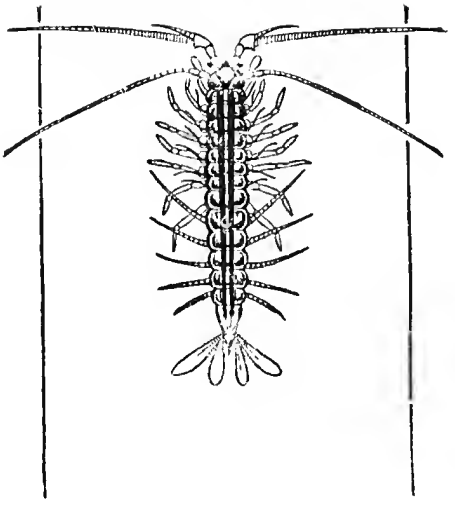
FIGURES 44-46

Figures 44-46 *Phreodrilus proboscidea* sp. nov.

44. Ventral setae of II.
45. Ventral setae of V.
46. Anterior end with proboscis.

No. 65

RECORDS OF THE QUEEN VICTORIA MUSEUM LAUNCESTON



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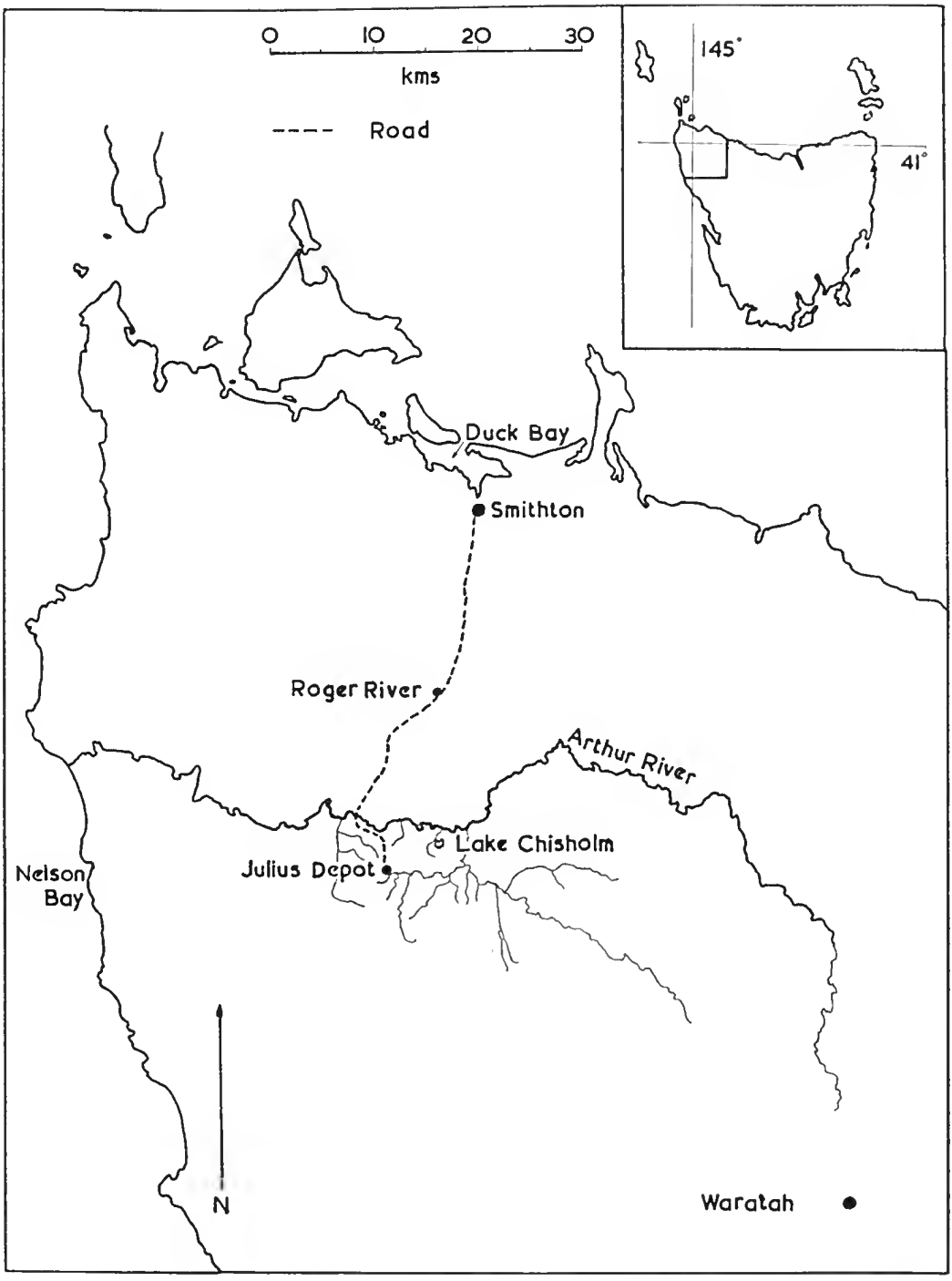

Figure 1 — North-west Tasmania and the region where the study was undertaken. The Sumac Forest and Dempster Plains are to the east of Julius Depot.

A SURVEY OF THE VERTEBRATE FAUNA OF THE SUMAC FOREST AND THE DEMPSTER PLAINS, NORTH-WEST TASMANIA

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ABSTRACT

Ten days were spent in an area of rainforest and wet sedgeland — heathland plains in north-western Tasmania, collecting and recording vertebrate animals and their ectoparasites.

Sixteen species of mammals, 40 birds, 3 reptiles, 3 frogs and 2 fish were recorded. Contrary to previous observations, *Antechinus minimus* was trapped in dense rainforest and ecotonal regions, where it was found to be common, apparently to the exclusion of *A. swainsonii*. Small dasyurids and murids were not found in what appeared to be suitable wet sedgland — heathland habitat, though they were common in adjacent rainforest.

Fleas were collected from 98 mammals.

INTRODUCTION

The Arthur River has until recently formed a barrier to vehicular penetration of an extensive area of forests and plains in north-west Tasmania.

The building of a bridge over the Arthur River about 25 km inland from the west coast, in 1971 and the construction of a network of roads by the Tasmanian Forestry Commission has recently provided easy and convenient access to this area for authorised personnel. With the help and cooperation of Forestry Commission staff, ten days, from 13th to 23rd March 1978, were spent on a survey of vertebrate fauna. The work was carried out by the author and two assistants in sections of the Sumac Forest and Dempster Plains to the east of the Julius Depot, a Forestry Commission works camp, located about 30 km east of Nelson Bay on the west coast and 35 km south of Duck Bay on the north coast (Figure 1). It is at an elevation of about 200m and has an annual precipitation of about 1700mm.

HABITAT

The vegetation in the area occurs as a well defined mosaic of forest and treeless wet sedgeland — heathland separated by a brief ecotone (Plate 1) and is typical of much of western Tasmania. It provides habitats for several species of small mammals (Green 1967, 1968, 1972).

The Sumac Forest area has never been logged and a spectacular feature is the very large and often over-mature *Nothofagus cunninghamii* (beech) trees in the areas of rain forest. Sclerophyll forest (Plate 2) also occurs in patches, its distribution being dependent upon the effects of fire, soil and climatic influences. Jackson (1965) discussed the results of these influences and their various ecotonal effects.

The treeless areas of the Dempster Plains are very fire prone in summer and may in part be the result of burning by aborigines before the advent of European settlement. They are presently maintained by periodic burning, both accidental and deliberately ignited. The Forestry Commission maintains a programme of burning sedgeland outside the high fire danger period. This provides natural fire breaks between the areas of forest by reducing accumulations of fuel. It also reduces the risk of uncontrolled and extensive forest fires in peak fire prone periods.

Plate 1 — The ecotone between the Dempster Plains and the Sumac Forest.

Plate 2 — A newly constructed road through a section of wet sclerophyll forest near Julius Depot.

As a result, the sedgeland — heathland plains vary considerably in the degree of ground cover and shelter they provide for small mammals. Populations of several species are dependent upon rather critical levels of regeneration. Their occurrence is therefore generally patchy, occurring primarily in semi-isolated pockets, whenever the habitat has reached a suitable standard of regrowth.

The time lapse and conditions following burning required for the establishment of tolerable and optimum habitat for the various animal species concerned has yet to be accurately defined and the present report illustrates this when discussing *Antechinus minimus* and *Rattus lutreolus*.

METHODS AND SOURCES OF DATA

Small mammals were collected by trapping with standard commerciial rat traps, Sherman tin traps (23 x 9 x 8cm) and wire cage traps (45 x 20 x 20cm). These were set at sites carefully selected as being the most likely places to catch. They were placed at 10-20m intervals in twisting lines determined by the best habitat. Traps were baited with bread and peanut butter and left set for 2-3 days before being removed to alternative sites.

Snap traps were set for about 500 trap nights in wet sedgeland — heathland habitat on Dempster Plains and for about 1300 trap nights in tea-tree scrub, ecotone and rainforest. Sherman traps were set for about 240 trap nights in rainforest and cage traps were set for 30 trap nights in rainforest and forest clearings.

Snap traps proved to be far the most successful and animals were often taken, apparently by firing the trap when running over the bait. Sherman traps rarely caught (eight occasions) animals apparently being shy to enter. Cage traps failed to take animals but were disturbed on six occasions, presumably by *Trichosurus vulpecula*. Six mist nets (10 x 2m) were set at Julius Depot for bats and nocturnal birds on six nights.

Spotlighting from a vehicle along forestry roads and on foot in the vicinity of Julius Depot was undertaken on several nights to search for larger animals.

Observations were made on the occurrence of all vertebrate animals whenever time and opportunity permitted. Calls of frogs were recorded on tape.

Collected mammals and birds were cloroformed in individual plastic bags, their ectoparasites so killed and removed by shaking or brushing the host over a sheet of white paper. All parasites thus collected were then sorted and preserved in 70% alcohol. After standard data was recorded, rodents, reptiles, amphibians and fish were preserved in 4% formalin; bats, marsupials, birds and sundry invertebrates were preserved in 70% alcohol.

Nomenclature for mammals follows Ride (1970); for birds, Schodde *et al.* (1978); for reptiles, Rowlinson (1974); for amphibians, Littlejohn & Martin (1974).

FAUNA LIST

The relatively short time spent in the area precludes an accurate assessment of the distribution and relative abundance of species present. The following annotated lists are therefore presented to record only the results of collections and observations made over the ten day period.

Mammals

Brush Wallaby *Macropus rufogriseus*
Several were seen by day in tall tea-tree scrub bordering the Dempster Plains and by night along roads through the Sumac Forest.

Tasmanian Pdemelaon *Thylogale billardieri*
Often seen when spotlighting along roads and about the edges of clearings in the rainforest.

Brush-tailed Possum *Trichosurus vulpecula*
Two were seen by spotlight in rainforest on the edge of a clearing.

Common Ringtail *Pseudocheirus peregrinus*
Three were seen in rainforest canopy by the roadside near Julius Depot.

Common Wombat *Vombatus ursinus*
Not seen but scats and footprints were commonly found throughout the area.

Brown Bandicoot *Isoodon obesulus*
One was seen when spotlighting amongst logs at Julius Depot and one was killed by a snap trap set for small mammals in heavy rainforest.

Tiger Cat *Dasyurus maculatus*
Not seen but scats consistent with those of this species were found in several places.

Tasmanian Devil*Sarcophilus harrisii*
Not seen but footprints in damp silt were found near Julius Depot.

Swamp Antechinus *Antechinus minimus*
Twenty-five were collected by trapping, principally in dense rainforest and to a lesser extent in tea-tree scrub and wet sedgeland — heathland econtone on the edges of the Dempster Plains. Three females were found to have recently finished lactating, two having six nipples enarged and one having five of her six nipples enlarged. The remaining 10 females and 12 males were all well developed sub-adults in non-breeding condition.

The occurrence of *A. minimus* in a rainforest habitat has not been previously recorded and presents an extension of the habitat types in which it is known to occur. Ride (1970, p. 119) noted its distribution as "Coastal south-eastern South Australia, coastal southern Victoria, Tasmania, islands of Bass Strait; tussock grassland, coastal complex", while Green (1973, p. 37) considered its preferred habitat as "dense wet sedgeland and adjacent swampy drainage systems". The latter's findings are based principally upon fieldwork in the Cradle Mountain — Waratah area of north-western Tasmania together with isolated findings in other parts of the state (Green, 1971). These earlier investigations indicated that *Antechinus swainsonii* occupied the rainforest habitat to the apparent exclusion of *A. minimus*.

An extensive area on the Dempster Plains, which had not been burnt for 16 years (N. Gellie, pers comm.) appeared, from previous experience, to be an ideal habitat for *A. minimus* and *Rattus lutreolus*. Searching in this area failed to find any evidence of runways or scats and trapping for 500 trap nights produced animals only in or near to the ecotonal region. No explanation is offered here for the apparent absence of *A. minimus* from what appeared to be suitable areas of wet sedgeland — heathland habitat and for its occurrence well inside heavy rainforest, to the apparent exclusion of *A. swainsonii*.

White-footed Dunnart *Sminthopsis leucopus*
Four sub-adults and an adult female which had recently ceased lactating were trapped in rainforest. The adult had only six discernable nipples, all in post-lactating condition.

Eastern Swamp-rat *Rattus lutreolus*
Fifty-five were trapped in rainforest and in the wet sedgeland — heathland ecotone. Contrary to expectations, it did not appear to be present in extensive areas of Dempster Plains which had remained unburnt for the previous 16 years and which appeared to be a highly acceptable habitat. No runways or scats were found in the area and trapping for 500 trap nights failed to yield rats in other than the ecotonal region.

About 50% of animals were sub-adult ((44-60 gm body weight). No pregnant or lactating rats were collected but in most adult females, the nipples were still enlarged and obvious. Most adult males were in a post-breeding decline with teste regression well advanced.

Ship Rat *Rattus rattus*
A pair with black pelage was trapped amongst logs about 100m from the buildings at Julius Depot. Though not lactating, nipple condition and teste development indicated recent breeding.

Long-tailed Rat *Pseudomys higginsi*
Thirty-five were trapped in the rainforest, about 60% of which were sub-adults (29-60 gm body weight). No pregnant or lactating rats were collected but the nipples were still enlarged and obvious on about 50% of adult females. The testes of adult males were well regressed.

House Mouse *Mus musculus*
One male and one female were trapped in dense rainforest. Though not pregnant or lactating, nipples were well developed and obvious. Testes were well developed.

Lesser Long-eared Bat *Nyctophilus geoffroyi*
Bats were seen flying about the clearings at Julius Depot on most evenings. Four males and two females were mist netted, none of which showed signs of having bred.

Platypus *Ornithorhynchus anatinus*
One was seen swimming on the surface of Lake Chisholm.

Birds

Hoary-headed Grebe *Poliocephalus poliocephalus*
One was seen on Lake Chisholm.

Great Cormorant *Phalacrocorax carbo*
Two were seen on Lake Chisholm.

White-faced Heron *Ardea novaehollandiae*
One was seen on the edge of Lake Chisholm.

Brown Goshawk *Accipiter fasciatus*
Individuals were seen on several occasions.

Wedge-tailed Eagle *Aquila audax*
Two were seen in the vicinity of Dempster Plains on several occasions.

Brown Falcon *Falco berigora*
Occasional birds were seen and heard.

Latham's Snipe *Gallinago hardwickii*
Not seen but footprints consistent with those of this species were found in drying ponds on Dempster Plains.

Yellow-tailed Black Cockatoo *Calyptorhynchus funereus*
Small numbers were regularly seen and heard.

Sulphur-crested Cockatoo *Cacatus galerita*
Small numbers were regularly seen and heard but they were not as common as *C. funereus.*

Ground Parrot *Pezoporus wallicus*
One was flushed on two occasions from heathland on Dempster Plains. It was favouring the less densely vegetated areas.

Swift Parrot *Lathamus discolor*
Seven were seen flying north at 0730 hours on 10th March.

Green Rosella *Platycercus caledonicus*
Pairs and small groups were regularly seen and heard in the forest.

Southern Boobook *Ninox novaeseelandiae*
Regularly heard at night in the vicinity of Julius Depot. Two were caught in mist nets set overnight.

White-throated Needletail *Hirundapus caudacutus*
Seen on most days, sometimes in dozens and often flying at considerable height, apparently feeding and without obvious migratory movement.

Tree Martin *Cecropis nigricans*
One was seen over Dempster Plains on 10th March.

Black-faced Cuckoo-shrike *Coracina novaehollandiae*
Small parties were occasionally seen and heard flying above the forest canopy, apparently on migration.

Pink Robin *Petroica rodinogaster*
Regularly seen and heard in the rainforest, usually in pairs.

Flame Robin *Petroica phoenicea*
Small parties were seen on several occasions at Julius Depot and other man-made clearings in the forest.

Dusky Robin *Melanodryas vittata*
A small party was seen at Julius Depot on several days.

Olive Whistler *Pachycephala olivacea*
Regularly seen and heard in the rainforest.

Grey Shrike-thrush *Colluricincla harmonica*
Regularly seen and heard in the forest and tea-tree scrub.

Grey Fantail *Rhipidura fuliginosa*
Commonly seen and heard in the forest and tea-tree scrub.

Superb Fairy Wren *Malurus cyaneus*
Often seen in small parties about the edges of forest clearings and occasionally deep inside the rainforest.

Southern Emu-wren *Stipiturus malachurus*
Not seen but clearly heard calling in sedgeland — heathland habitat on Dempster Plains.

White-browed Scrubwren *Sericornis frontalis*
One of the most commonly encountered birds, being seen in pairs and small parties throughout the rainforest and tea-tree scrub.

Scrubtit *Sericornis magnus*
Commonly seen in the rainforest.

Calamanthus *Sericornis fuliginosus*
These birds were occasionally seen on Dempster Plains.

Tasmanian Thornbill *Acanthiza ewingii*
One of the most commonly encountered birds, being seen in rainforest, tea-tree scrub and on the edges of forest clearings.

Yellow-throated Honeyeater *Lichenostomus flavicollis*
Regularly seen and heard calling in the forest.

Strong-billed Honeater *Melithreptus validirostris*
Small parties were occasionally seen and heard in the rainforest canopy.

Crescent Honeyeater *Phylidonyris pyrrhoptera*
Commonly seen and heard in the rainforest.

Eeastern Spinebill *Acanthorhynchus tenuirostris*
Occasionally seen about the edges of rainforest.

Spotted Pardalote *Pardalotus punctatus*
Occasionally heard calling in the rainforest canopy.

Striated Pardalote *Pardalotus striatus*
Occasionally heard calling in the forest canopy.

Silvereye *Zosterops lateralis*
Often seen and heard in rainforest, usually in small parties.

European Goldfinch *Carduelis carduelis*
Small parties were seen and heard in rainforest on several occasions.

Beautiful Firetail *Emblema bella*
Small family parties comprising an adult pair and juveniles were seen on several occasions about the edges of clearings in rainforest. Juveniles were being fed by adults.

Grey Butcherbird *Cracticus torquatus*
Heard calling on several occasions from forested areas near Dempster Plains and at Julius Depot.

Black Currawong *Strepera fuliginosa*
Commonly seen and heard throughout the area.

Forest Raven *Corvus tasmanicus*
Pairs and individuals were occasionally seen. Near Dempster Plains a congregation of about ten were attracted by Wedge-tailed Eagles.

Reptiles

Tiger Snake *Notechis ater*
One was found dead on the roadside near Dempster Plains.

White-lipped Snake *Drysdalia coronoides*
One was collected in dense rainforest near Julius Depot. Upon dissection, it was found to have eaten the tails of several skinks.

Metallic Skink *Leiolopisma metallica*
Commonly seen in forest clearings and occasionally in rainforest.

Amphibians

Smooth Froglet *Crinia laevis*
Commonly found beneath litter in drains and damp depressions throughout the area. It was calling vigorously and spawning was at a peak. Twenty-four specimens were collected and found to be of two fairly distinct colour forms. Calls were tape recorded and submitted to Dr. Murray Littlejohn, University of Melbourne, for sonagraphic analysis. Ambient wet bulb air temperature was not recorded and only a generalisation as to the specific status of the callers could be made. This was that the pulse rate was not significantly different from those of *C. laevis* (Littlejohn, pers. comm.).

Tasmanian Froglet *Crinia tasmaniensis*
One was heard calling at night from a small creek near Julius Depot.

Brown Tree-frog *Litoria ewingi*
Regularly heard calling from ponds in forest clearings. Three were collected.

Fish

Native Trout *Galaxias brevipinis*
Common in rivers and streams throughout the area. Fourteen were collected from the Julius River near the Julius Depot.

Brown Trout *Salmo trutta*
Common in rivers and streams throughout the area.

Sundry Invertebrates

Ninety-eight sets of fleas were collected from mammalian hosts and 57 sets of other ectoparasites were collected from various hosts. Four frestwater crayfish *Astacopsis gouldi* were collected from Stephens Rivulet near the Arthur River bridge and sundry insects, spiders and molluscs were collected as opportunity permitted.

COMMENTS

The road systems presently developed south of the Arthur River now provide an easy access for authorised personnel and an excellent opportunity for research in an impressive area of climax rainforest and associated plains. General zoological survey work in such habitats is desirable and this previously isolated and inaccessible area now provides the opportunity to study the ecology of the rainforests and plains of north-west Tasmania in an area which has not yet been subjected to disturbance by logging operatings of any kind.

ACKNOWLEDGEMENTS

Grateful acknowledgement is made of the cooperation and help given by the Tasmanian Forestry Commission and staff without which the collecting programme and survey would have been impractical.

Thanks are also due to J. D. von Stieglitz who participated in the work as an honorary assistant and C. O. Ockenden, Research Assistant with the Forestry Commission, both of whom gave untiringly of time and effort.

The project was initiated and supported financially by Professor Robert Traub, University of Maryland, U.S.A., as part of a major study of the taxonomy and ecology of the siphonoptera fauna of Tasmania. To him I also express my sincere thanks.

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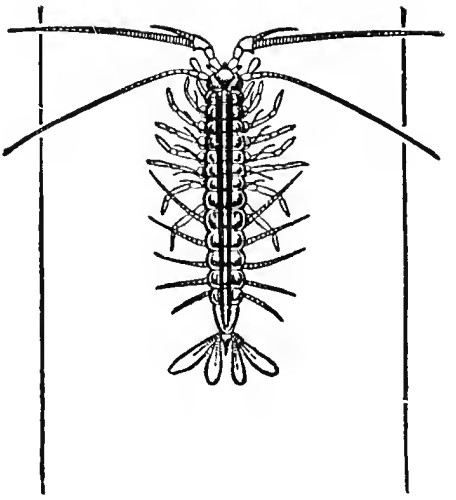
No. 66

RECORDS OF THE QUEEN VICTORIA MUSEUM LAUNCESTON



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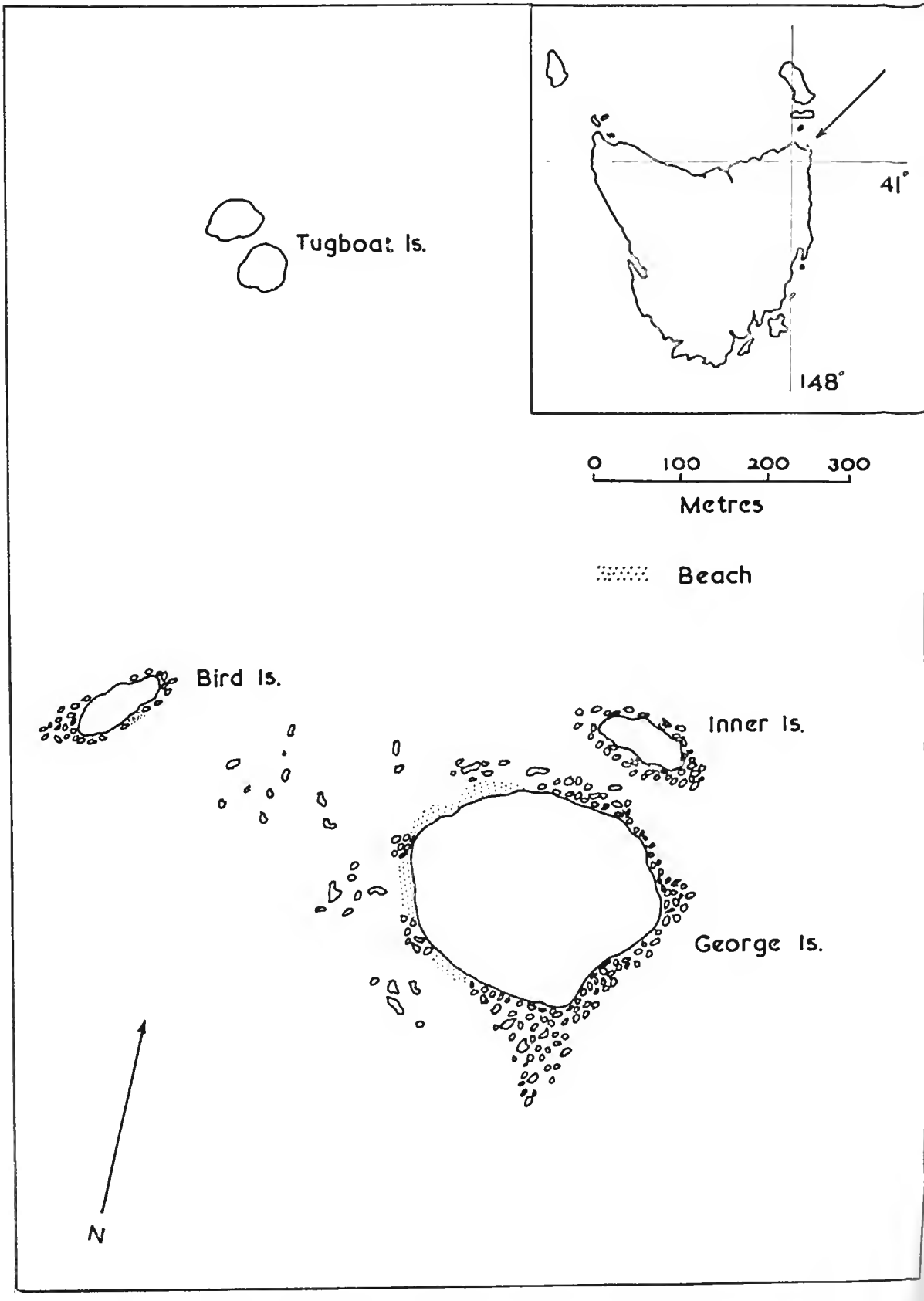

Figure 1 The George Rocks group, showing the main islands. Inset, Tasmania with George Rocks indicated by the arrow.

BIOLOGICAL OBSERVATIONS, GEORGE ROCKS, NORTH-EASTERN TASMANIA

by

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ABSTRACT

Eleven days, from 12 to 23 November 1977, were spent on and around the George Rocks group of islands off the north-east coast of Tasmania. Notes on the island vegetation, 3 species of mammals, 33 birds, 1 reptile, 18 marine fishes and some sundry invertebrate animals collected and/or observed are given.

INTRODUCTION

George Rocks is a granite formation situated about 5 km off the north-east coast of Tasmania (lat. 40° 55' S., long. 148° 19' E., Fig. 1). It is comprised of three small vegetated islands and a number of exposed rocks of various sizes forming a group which is of local ornithological significance. This has resulted in visits by others on numerous occasions. Napier & Singline (in press) summarised the results of their observations between 1970 and 1977. It was proclaimed a State Reserve in 1975 and forms part of the Mount William National Park of the adjacent mainland.

Through the generosity and assistance of Mr. Trevor Singline, the present author and his son W. H. Green were able to visit the group in November 1977, living on the main island for four days (12-16 November) and spending seven days (16-23 November) aboard the fishing boat "Eastern Star" in adjacent waters. Mr. Singline's knowledge of the birds of the area has contributed greatly to the present paper and Mr. Arthur Pike of the fishing boat "Oceanites" who has fished in the area for many years and lived in a hut on George Island from October 1946 until the following winter also provided information.

DESCRIPTION

George Island (= Main Island) is the largest of the group, being roughly circular, about 300 m across and about 30 m high. The granite rock is partly covered by sandy soil and fretted granite gravel which has built up with humus and now supports a variety of vegetation (Table 1). Three small granite beaches on the north-west, west and south sides provide good landing sites (Plate 1). The remainder of the coast is rocky and boulder strewn. Fresh water seeps and drains into rock ponds above high tide on the north-east coast providing drinking water at about three points. Tall granite outcrops give some protection from wind. (Plate 2). Occasional firing of the vegetation has reduced soil fertility and exposed the sand and gravel in many places.

Inner Island (= North-east Island) is separated from the northern shore of George Island by a deep gulch about 30 m wide. It is roughly oval in shape being about 100 m east-west by 50 m north-south. Prominent granite boulders are separated by patches of sandy soil which support some vegetation (Table 1). There is a small fresh water pond in the centre of the island. The shore is rocky and a landing is possible only in calm weather.

Bird Island is about 500 m north-west of George Rock. It is roughly oval in shape, about 100 m by 50 m and about 15 m high. It slopes gently to a small beach on the eastern side which provides a good landing site. Sandy soil, rich in humus, over much of the island supports some vegetation (Table 1). There is no evidence of firing.

Plate 1 The western side of George Island showing the granite gravel beaches. The Silver Gull and Crested Tern colonies are on the extreme right.

Plate 2 The northern end of George Island with the Tasmanian mainland in the distance.

Tugboat Island is about 1 km north of George Island and consists of two bare granite rocks about 100 m across and 15 m high. Sheltered areas above high tide provide nesting ledges but soil and vegetation are absent.

A cluster of granite pinnacles and boulders, about 100 m off the southern shore of George Island, support pigface which grows from crevices and there are numerous other outcrops, rocks and reefs, most of which are regularly washed by the sea.

BOTANY

The vegetation of the islands is predominantly low-growing shrubs, grass and pigface (FICOIDEAE), fairly typical of that found on small offshore islands. A single Boobyalla *Acacia sophorae*, heavily wind pruned, 4 x 4 x 2 m high, growing in the centre of George Island, is the only tree in the group. A few rushes (JUNCACEAE) grow about the fresh-water soaks on the east coast of George Island.

A single small fern *Hypolepis* sp. was found growing from a rock crevice on the south-east side of George Island.

Occasional firing has removed vegetation and surface humus in patches, exposing the granite sand to erosion.

Browsing of the fine grasses by rabbits was most noticeable at the time of the visit.

A collection of plants formed during the visit and lodged in the Queen Victoria Museum herbarium is summarised in Table 1. Some undetermined grasses were also collected.

MAMMALS

Rabbit *Oryctolagus cuniculus*

Introduced to George Island by local fisherman about 1936 (Pike pers. comm.) where it has since persisted with a peak population of about 20 adults. Pike recalled at least one black rabbit on the island in 1946 and Singline (pers. comm.) recalled that blacks pre-dominated about 1964. Rabbits were commonly seen during our visit, including a nest of four furred young and one about half grown but all were of normal grey pelage. Scratching and scats were prevalent and skeletal remains were numerous but excessive damage was not found. A rabbit was seen on Bird Island in 1974, severely infected with myxomatosis but rabbits do not occur there now.

Ship Rat *Rattus rattus*

Rats, almost certainly of this species, occur on George Island. None were seen but at least one invaded the camp nightly and fed on scraps. Rat dung, the dessicated remains of a rat and the remains of storm-petrels were found beneath poa tussocks and pigface at an old hut site on the western shore. It was considered that the presence of this rat may have been responsible for mortality amongst storm-petrels and was thus a deterrent to their breeding on George Island. There was no evidence of rats on any other islands in the group. It was not present on George Island in 1946-1947 (Pike pers. comm.).

Australian Fur Seal *Arctocephalus doriferus*

Individuals are commonly seen in the area and often trouble commercial fishermen when they are attracted to buoys and nets. Captain James Kelly found "a large number of seals" when he visited George Rocks in January 1816, taking 172 skins in nine days. He also recorded the presence of small seal pups (Kelly, 1921). The nearest present breeding colony is on Moriarty Rocks near Clark Island, about 40 km north (Green, 1973).

BIRDS

The birds of George Rocks and the adjacent sea are summarised in Table 2. Unless otherwise stated, the following comments are based upon the author's observations, 11-24 November 1977. Nomenclature follows that of Schodde *et al.* (1978).

Little Penguin *Eudyptula minor*

About 100 occupied nests were noted on George Island. These contained adults apparently ready to lay, adults with eggs, and young at various stages of development up to about three-quarters grown. Most nests with advanced young were heavily infested with fleas and other invertebrates. About 25 pairs breed on Inner Island and about ten pairs on Bird Island.

Wandering Albatross *Diomedea exulans*

Seen only rarely by Singline (pers. comm.).

Black-browed Albatross *Diomedea melanophrys*

A few birds were seen regularly, often coming close to the boat to take food scraps.

Yellow-nosed Albatross *Diomedea chlororhynchos*

A few birds were seen regularly and were occasionally attracted to craypot buoys.

TABLE 1 The vegetation of the three main islands in the George Rocks group. F = few; C = common; A = abundant.

	George Island	Inner Island	Bird Island
Dicotyledons			
Caryophyllaceae			
Sagina maritima	–	C	C
Chenopodiceae			
Atriplex hastata	–	–	C
Salicornia (quinquefolia?)	–	–	A
Compositae			
Cirsium vulgare	A	–	–
Gnaphalium sp.	C	–	–
Senecio capillifolius	–	A	A
Sonchus asper	C	–	–
Sonchus oleraceus	–	F	F
Convolvulaceae			
Dichondra repens	C	–	–
Crassulaceae			
Crassula sieberiana	C	C	–
Cruciferae			
Cakile sp.	C	–	–
Lepidium sp.	–	–	C
Epacridaceae			
Leucopogon parviflorus	C	–	–
Ficoideae			
Carpobrotus rossii	A	A	A
Tetragonia implexicoma	–	C	A
Geraniaceae			
Pelagonium australe	F	F	–
Leguminosae			
Acacia sophorae	F	–	–
Malvaceae			
Lavatera sp.	–	–	C
Primulaceae			
Anagallis arvensis	C	–	–
Polygonaceae			
Muehlenbeckia edpressa	C	–	–
Umbelliferae			
Apium prostratum	–	–	C
Monocotyledons			
Centrolepidaceae			
Centrolepis strigosa	C	–	–
Cyperaceae			
Scirpus cernuus	–	–	C
Gramineae			
Hordeum leporinum	–	C	–
Poa sp.	A	C	C
Poa sp.	C	C	C
Poa sp.	C	–	–
Juncaceae			
Unidentified	C	–	–
Unidentified	C	–	–
Pteridophyta			
Hypolepis sp.	F	–	–
Microsorium diversifolum	F	–	–

TABLE 2 The birds of the George Rocks group and adjacent waters discussed in the text. Approximate numerical status is indicated by F = few, < 5 sightings per day; C = common, 5-20 sightings per day; A = abundant, > 20 sightings per day; b = breeding locally; ? = not every year; * = observed at sea. Nomenclature follows Schodde *et al.* (1978).

Species	George Island	Inner Island	Bird Island	Tugboat Island	Adjacent Seas	Napier & Singline (in press)	
						George Rocks	At Sea
Little Penguin *Eudyptula minor*	Ab	Ab	Cb		A	Cb	
Wandering Albatross *Diomedea exulans*					F		*
Black-browed Albatross *Diomedea melanophrys*					C		*
Yellow-nosed Albatross *Diomedea chlororhynchos*					C		*
Shy Albatross *Diomedea cauta*					C		*
Giant Petrel *Macronectes* sp.					F		*
Cape Petrel *Daption capense*					F		*
Fairy Prion *Pachyptila turtur*							*
Short-tailed Shearwater *Puffinus tenuirostris*	Ab				A	Cb	
White-faced Storm-petrel *Pelagodroma marina*	F		Ab		A	Cb	
Common Diving-petrel *Pelecanoides urinatrix*			Cb		A	Cb	
Australian Pelican *Pelecanus conspicillatus*					F		*
Australian Gannet *Morus serrator*					A		*
Black-faced Shag *Leucocarbo fercescens*	C	Cb?	Cb?	Ab	A	Cb	
Little Pied Cormorant *Phalacrocorax melanoleucos*					F		
Great Cormorant *Phalacrocorax carbo*	F	F	F		C		
White-faced Heron *Ardea novaehollandiae*	F					F	
Black Swan *Cygnus atratus*					C		
Pacific Black Duck *Anas superciliosa*					C		
White-bellied Sea-eagle *Haliaeetus leucogaster*					F		*
Marsh Harrier *Circus aeruginosus*	F					F	

(Table 2 continued)

Species	George Island	Inner Island	Bird Island	Tugboat Island	Adjacent Seas	Napier & Singline (in press)	
						George Rocks	At Sea
Pied Oystercatcher *Haematopus longirostris*						F	
Sooty Oystercatcher *Haematopus fuliginosus*	Fb	Fb?	Fb			Fb	
Hooded Plover *Charadrius rubricollis*	Fb?					Fb	
Red-capped Plover *Charadrius ruficapillus*						F	
Ruddy Turnstone *Arenaria interpres*	N					N	
Eastern Curlew *Numenius madagascariensis*						F	
Arctic Jaeger *Stercorarius parasiticus*					F		•
Silver Gull *Larus novaehollandiae*	Ab	Cb	Ab?	F	A	Ab	
Pacific Gull *Larus pacificus*	F	F	Cb	F	C	Cb	
Caspian Tern *Hydroprogne caspia*			Fb		F	Fb	
Fairy Tern *Sterna nereis*					F		F
Crested Tern *Sterna bergii*	Ab		Ab?		A	Ab	
Welcome Swallow *Hirundo neoxena*	F						
Richard's Pipit *Anthus novaeseelandiae*	F					F	
Satin Flycatcher *Myiagra cyanoleuca*	F						
White-fronted Chat *Epthianura albifrons*						F	
Common Starling *Sturnus vulgaris*	F		Fb			Fb	
Forest Raven *Corvus tasmanicus*	F	F	F			F	

Shy Albatross *Diomedea cauta*
A few birds were seen regularly.

Giant Petrel *Macronectes* sp.
Singline (pers. comm.) has occasionally seen these birds.

Cape Petrel *Daption capense*
Singline (pers. comm.) has seen a few occasionally.

Fairy Prion *Pachyptila turtur*
Recorded by Napier & Singline (in press) without comment.

Short-tailed Shearwater *Puffinus tenuirostris*
A few pairs have bred annually on George Island for many years but none have been found on other islands in the group (Pike & Singline pers. comm.).

White-faced Storm-petrel *Pelagodroma marina*
Pike (pers. comm.) recalled this species breeding prolifically on the northern side of George Island about 1946. Napier & Singline (in press) found eggs there in the latter half of November. It was not found to have established nests when we left on 16 November though laying had commenced on the north-east end of Bird Island when we visited there on 15 November. Singline (pers. comm.) found about 60 nests on Bird Island in 1973 and gained the impression that this species was utilising the abandoned burrows of the much earlier breeding Diving Petrel. Observations during the present study led to the same conclusion. Predation by rats may now prevent it from breeding successfully on George Island.

Common Diving-petrel *Pelecanoides urinatrix*
First found breeding on Bird Island on 14 November 1975 when Singline (pers. comm.) estimated about 25 nests with large downy young on the eastern end and they are known to have bred there every year since. Only one large young and one adult were found on 15 November 1977.

Australian Pelican *Pelecanus conspicillatus*
One has been seen occasionally by Singline (pers. comm.).

Australian Gannet *Morus serrator*
Commonly seen throughout the area, especially so in the evenings. Congregations of up to 40 were often seen on and around Gannet Rock about 1 km to the south of George Island. Singline (pers. comm.) has seen an estimated 400 roosting at night on Victoria Rocks, east of Eddystone Lighthouse, about 10 km south of George Rocks.

The 'hawking' flight of gannets was observed as they congregated about sunset, wheeling and turning at a great height, often in loose groups.

Black-faced Shag *Leucocarbo fuscescens*
Commonly seen about George Rocks, often in dozens. Pike (pers. comm.) recalled it breeding regularly in considerable numbers on the granite pinnacles and boulders off the south shore of George Island until about 1955. Singline (pers. comm.) has found its numbers and breeding sites vary from year to year. On Tugboat Island he has seen up to 50 nests. On landing there on 16 November 1977, there were eight nests containing eggs to large young on the south-eastern rock. It also nests haphazardly on Inner Island, Bird Island and the pinnacle rocks off the southern shore of George Island. Up to 300 have been seen roosting at night on Victoria Rock (Singline pers. comm.).

Great Cormorant *Phalacorocorax carbo*
Commonly seen in the area during the visit, on some occasions up to 20 in a group. It was far more prevalent in 1977 than in former years (Singline pers. comm.).

Little Pied Cormorant *Phalacrocorax melanoleucos*
A few birds have been seen occasionally flying along the coast (Singline pers. comm.).

White-faced Heron *Ardea novaehollandiae*
A single bird has been seen occasionally on the rocky intertidal zone (Singline pers. comm.).

Black Swan *Cygnus atratus*
Up to ten have been seen occasionally flying along the coast (Singline pers. comm.).

Cape Barren Goose *Cereopsis novaehollandiae*
Captain James Kelly caught for food a number of young birds during his visit in January 1816 (Kelly, 1925). It has not been recorded there in recent years.

Pacific Black Duck *Cygnus atratus*
Up to ten have been seen occasionally flying along the coast (Singline pers. comm.).

White-bellied Sea-eagle *Haliaeetus leucogaster*
A single bird has been seen occasionally (Singline pers. comm.).

Marsh Harrier *Circus aeruginosus*
A single bird has been seen occasionally, hunting over the islands (Singline pers. comm.).

Pied Oystercatcher *Haematopus longirostris*
Napier & Singline (in press) recorded it as "scarce at George's Rocks".

Sooty Oystercatcher *Haematopus fuliginosus*
A pair nesting on the north-western beach of George Island hatched two young on 15 November 1977 and a pair were found with two eggs on Bird Island on the same date. Singline (pers. comm.) has found it nesting on all three vegetated islands in the group.

Hooded Plover *Charadrius rubricollis*
Singline (pers. comm.) found a pair with three eggs on the north-western beach of George Island at the end of November 1974.

Red-capped Plover *Charadrius ruficapillus*
Napier & Singline (in press) recorded it as "sometimes seen on George's Island beaches".

Ruddy Turnstone *Arenaria interpres*
About 40 were living about the intertidal zone of George Island during this survey. It no doubt visits the other islands in the group.

Eastern Curlew *Numenius madagascariensis*
Napier & Singline (in press) recorded one occurring frequently on George Island.

Arctic Jaeger *Stercocarius parasiticus*
A few birds were seen regularly, often harrying Crested Terns which were carrying small fish back to George Island from the north.

Silver Gull *Larus novaehollandiae*
Abundant throughout the area. It had just commenced to lay on the tidally-isolated rocks on the south-east end of George Island on 14 November 1977. When Bird Island was visited on 15 November 1977, about 100 were found gathered on rocks and amongst vegetation on the south-east slope. Nests were being formed but laying had not commenced.

Singline (pers. comm.) has found it changes its nesting sites from year to year but on George Island up to 150 pairs nest regularly. On Inner Island up to 150 pairs have nested in some years and none in others. It has been irregular on Bird Island with 150 nests being the maximum in any year.

Singline (pers. comm.) found it collected the fruit of *Leucopogon parviflorus* from the adjacent mainland, apparently to feed its young, the rookeries being covered with the indigestable seeds. A few plants of this species grow on George Island and Inner Island, apparently having been established there by birds transporting the fruit.

Pacific Gull *Larus pacificus*
Common throughout the area but none were found nesting. Singline (pers. comm.) has found up to eight nests in one season on Bird Island but has never found it nesting on George Island.

Caspian Tern *Hydroprogne caspia*
One pair had a nest with three newly hatched young on Bird Island on 15 November 1977. Singline (pers. comm.) has found a pair to breed there every year but has never found it nesting on George Island.

Fairy Tern *Sterna nereis*
Singline (pers. comm.) has occasionally seen it fishing in adjacent waters.

Crested Tern *Sterna bergii*
Abundant in the area. It had just commenced to lay on the south-east end of George Island on 12 November 1977. On 15 November about 250 nests with eggs were counted and about another 250 pairs were already assembled and daily adding to the extent of the colony. Copulation was observed on dozens of occasions. Many birds flew in pairs about the colony and when going to and from their feeding areas. In the evenings, they engaged in paired acrobatics, often at a great height and speed, one continuously trailing close behind the other.

Many birds were seen to return to the island carrying small fish ($<$100 mm). These were found to include Scad *Trachurus declivis* and Morwong *Cheilodactylus spectabilis*.

Singline (pers. comm.) first found it nesting on George Island in 1976 and estimated the colony to then contain at least 2,000 nests. Crested Terns were not nesting on George Island in 1946 but considerable numbers then bred on Bird Island and Inner Island (Pike pers. comm.). Singline (pers. comm.) has found up to 200 pairs breeding on rocks above the shore in the eastern inlet of Bird Island in some years while in other years that island is not utilised. Food gathering appears to take place to the North, possibly in the vicinity of Banks Strait.

Welcome Swallow *Hirundo neoxena*
Two were seen over George Island on 14 November 1977.

Richard's Pipit *Anthus novaoseelandiae*
Napier & Singline (in press) recorded having seen this species on George Island.

Satin Flycatcher *Myiagra cyanoleuca*
A female was seen sheltering amongst the low shrubs on George Island on 14-15 November 1977.

White-fronted Chat *Epthianura albifrons*
Napier & Singline (in press) recorded seeing it frequently on George Island.

Common Starling *Sturnus vulgaris*
Two were often seen about George Island and on the pinnacle rocks close to the southern shore. Singline (pers. comm.) has found a pair nesting in a rock crevice on the north-east end of Bird Island.

Forest Raven *Corvus tasmanicus*
One or two were seen occasionally flying over George Island.

REPTILES

Metallic Skink *Leiolopisma metallica*
Occurs commonly all over George Island.

FISH

The following species, with number of individuals in parentheses, collected in the George Rocks area 12-13 November 1977, have been added to the Queen Victoria Museum collections.

Alabidae
Alabes rulus Shore Eel (26).

Syngnathidae
Phyllopteryx taeniolatus Common Seadragon (1).

Mugilidae
Aldrichetta forsteri Yellow-eyed Mullet (18).

Scorpaenidae
Ruboralga ergastulorum Red Rock Cod (29).
Helicolenus papillosus Red Gurnard Perch (6).

Carangidae
Trachurus declivis Scad (1).

Girellidae
Girella tricuspidata Luderick (45).

Cheilodactylidae
Cheilodactylus spectabilis Brown-banded Morwong (1).

Scorpidae
Scorpis lineolatus Sweep (1).

Bovichthyldae
Bovichtus variegatus Dragonet (24).

Gobiidae
Callogobius mucosus Sculptured Goby (1).

Blenniidae
Pictiblennius tasmanianus Blenny (1).

Clinidae
Clinus perspicillatus Common Weedfish (33).
Clinus puellarum Low Head Blenny (1).

Tripteryglidae
Gillias macleayana Three-fin (4).

Labridae
Pseudolabrus cf. *celidotus* Parrot Fish (3).

Gobiesocidae
Creocele cardinalis Clingfish (1).
Undetermined Clingfish (undescribed species?) (1).

SUNDRY INVERTEBRATE ANIMALS

The following species were collected in the George Rocks area, 12-23 November 1977 and added to the Queen Victoria Museum collection. Determinations are tentative.

Crustaceans

Decapoda

Palaemonidae
cf. *Leander* sp.
This prawn was found to be very common in tidal pools.

Hippolytidae
cf. *Hippolyte* sp.
Two prawns, of different species, were collected from a tidal pool.

Palinuridae
Jasus lalandii Southern Rock Lobster
Very common, also the phyllosoma larvae in considerable numbers were sometimes found on ropes and lobster pots while hauling.

Paguridae
Clibanarius strigimanus Stridulating Hermit-crab
Very common, occurring in tidal pools and often hauled up in lobster pots. It was found in widely ranging sizes and occupying a variety of shells.

Dromiidae
Petalomera lateralis Ridged Sponge-crab
A few were found in tidal pools.

Majidae
cf. *Naxia* sp. Spider-crab.
A very few were found in tidal pools.

Lithodidae
Lomis hirta Hairy Stone-crab.
A few were found in the tidal pools.

Grapsidae
Cyclograpsus audouinii Smooth Shore-crab
Very common in the tidal pools.

Leptograpsus variegatus Common Shore-crab
Commonly found living in the intertidal zone. One was found feeding on an apparently freshly captured Weedfish *Clinus perspicillatus*.

Plagusia chabrus Cleft-fronted Shore-crab
Common in deeper water, often being hauled up in lobster pots.

Amphipoda

Grammaridae
cf. *Melita* spp. Two species of sea-fleas were commonly found in the tidal pools, two other species were less numerous.

Isopoda

Sphaeromidae
Marine Pill-lice
Rare, only five of four species being collected in the tidal pools.

Philosciidae
A Slater *Plymohiloscia ulverstonensis* was found to be very numerous in the nesting chambers of bird burrows on Bird Island.

Insects

Blattodea
One species of cockroach was found to be common.

Dermaptera
Two earwigs of one species were collected on George Island.

Diptera
One species of fly was bred from larvae collected from the nest of a penguin.

Hymenoptera
One parasitic wasp was collected on George Island. A series of small black ants was collected from beneath stones on George Island.

Arachnids

Araneida
Six spiders of three species were collected on George Island.

False Scorpions
One pseudo scorpion was collected on George Island.

Sea Spiders
Three pycnogonids were collected from weed hauled up on lobster pots.

Coelenterates

Actiniaris
One species of sea-anemone (cf. *Phlyctenanthus* sp.) was found to be common in tidal pools.

Molluscs

Teleoplacophora
Cryptorplax sp. Chiton
Common in intertidal pools.

Fissurellidae
Scutus antipodes Elephant Snail.
Common in tidal pools.

Nudibranchia
Two species were collected from tidal pools.

Echinoderms

Asteroidea
Five species of sea-stars were collected from tiday pools and lobster pots.

Ophiuroidea
Two species of brittle-stars were collected from tidal pools.

Echinoidea
Four species of sea-urchins were collected from tidal pools.

Holothuroidea
One species of sea-cucumber was collected from tidal pools.

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I wish to thank Mr. Trevor Singline for his help and co-operation in transporting us and all our equipment to the George Rocks group, for subsequently accommodating us on his fishing boat "Eastern Star" and for readily sharing his extensive knowledge of the area. I thank also my son Bill who took leave to accompany me and who assisted with the collection and processing of material and data.

Mrs. Mary Cameron, Honorary Associate in Botany, Queen Victoria Museum, identified the botanical specimens; Mr. E. O. G. Scott, Honorary Associate in Ichthyology, Queen Victoria Museum, identified the fish; and Miss Alison J. A. Green, Tasmanian Museum, identified the terrestrial isopods. The map was drawn by Miss Judy Gadsby.

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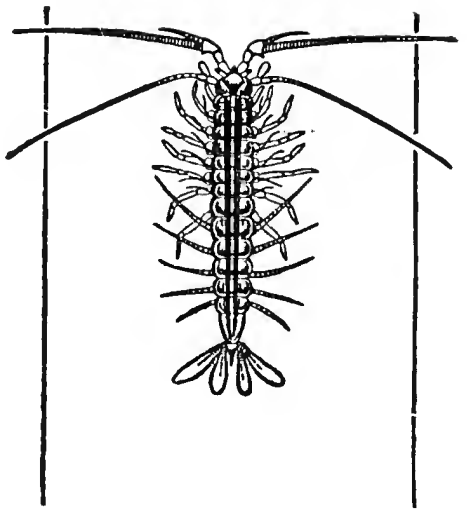
No. 67

RECORDS OF THE QUEEN VICTORIA MUSEUM LAUNCESTON



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Director of the Museum

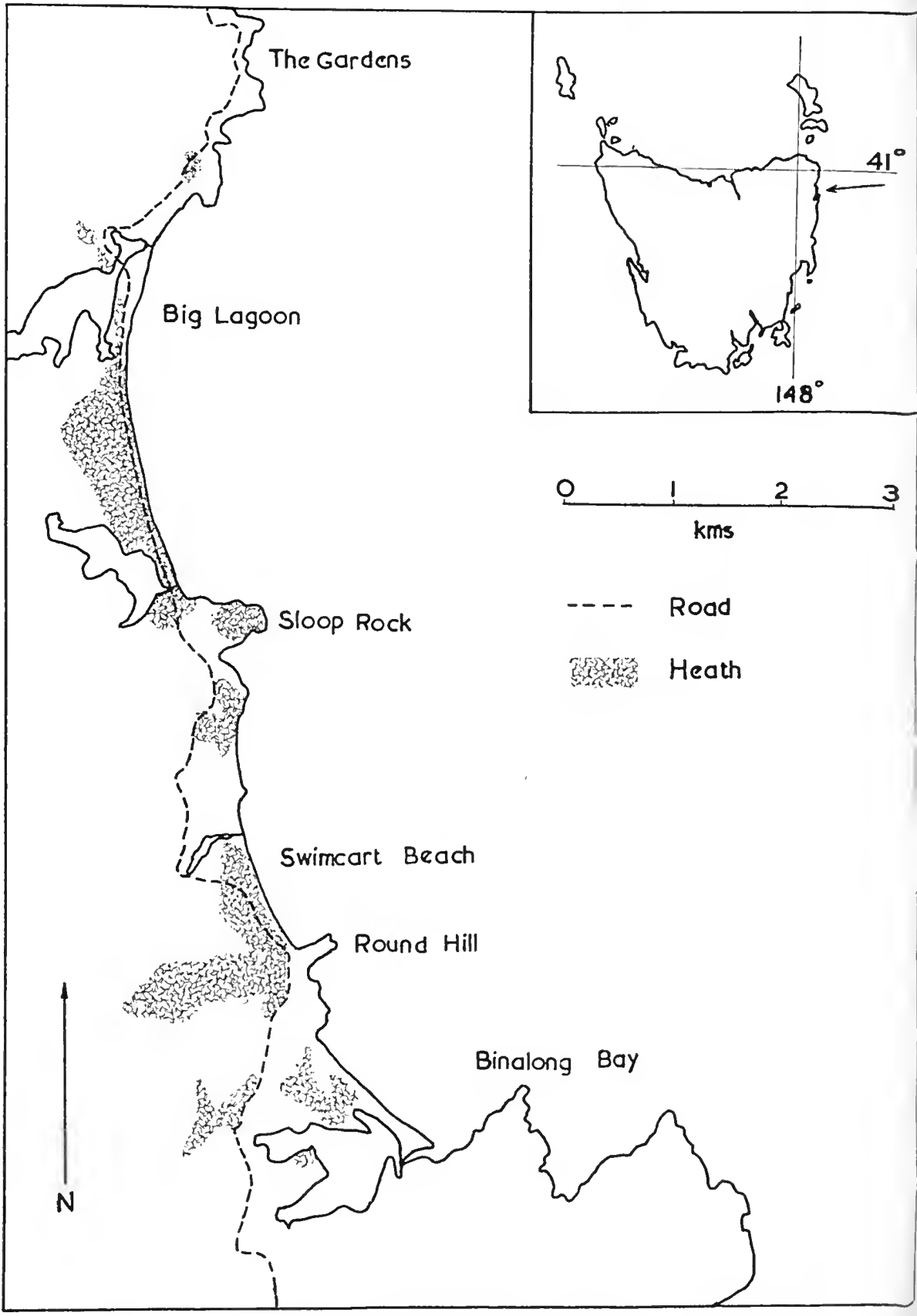

Figure 1 The north-east coast of Tasmania, where the study was undertaken. The distribution of heath is after Kirkpatrick (1977). Inset, Tasmania with the survey site indicated by the arrow.

A SURVEY OF THE VERTEBRATE FAUNA OF A HEATHLAND AREA BETWEEN ROUND HILL AND THE GARDENS, NORTH-EAST TASMANIA

by

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ABSTRACT

Eleven days, from 25 September to 6 October 1978 were spent in collecting and recording vertebrate animals and their ectoparasites in an area of coastal heathland in north-eastern Tasmania. Fifteen mammal species, 24 birds, 7 reptiles and 4 amphibians were found living in the heathland. An additional 24 bird species were found in the immediate vicinity. Fleas were collected from 124 mammals of 5 species.

INTRODUCTION

The coastal heathland of north-eastern Tasmania has been considerably reduced in recent years (Kirkpatrick, 1977), much having gone under the plough and sown to improved pasture for sheep or cattle grazing. The remaining areas have been subjected to periodic burning but probably not more so than was the case prior to European settlement. Cattle grazing occurs on some heathland areas but in general the surviving heathland habitat is probably somewhat similar to that of pre-European settlement. Block clearing for the development of holiday homes and camping facilities continues to deplete vegetation on some coastal strips where the terrain is suitable.

Because of the continuing pressure on the remaining heathlands, it was considered desirable to undertake a limited collecting programme in this habitat and the Round Hill - Gardens area was selected. (Fig. 1). The objectives were to seek further knowledge of the status of animals in an area of typical north-east heathland and to strengthen the collections of zoological research material. Since this work was undertaken, the Tasmanian Department of Lands has declared all Crown Land from Binalong Bay northwards to Ansons Bay to be a State Reserve.

Eleven days, from 25 September to 6 October 1978 were spent in trapping small mammals and general collecting and observing, the work being carried out by the author and one volunteer assistant.

The sea birds offshore are discussed by Green (1979).

HABITAT

Kirkpatrick (1977) in his study of heathland in Tasmania stated that "The heaths between Binalong Bay and the Gardens occur principally on Crown Land and partially on private land. However, much of the Crown Land has been occupied by shacks. The area consists of an extremely attractive mixture of turquoise seas, lichen-red granite tors, lagoons, heath and forest."

The heathland is confined to the coast and is broken up into isolated blocks by dry sclerophyll forest growing on ridges and small hills which have extended in places from the more elevated inland areas towards the coast. No agricultural development has taken place between Binalong Bay and the Gardens but the latter is the site of an old and well established pastoral property on which grazing has been carried out for many years.

Plate 1 Wet heathland west of Round Hill. The area is a natural basin into which water drains from the surrounding hills.

Plate 2 Dry heathland on elevated, well drained, sandy ridges near Big Lagoon. The specimens of *Antechinus minimus* and *Pseudomys novaehollandiae* were collected in this area.

TABLE 1 **Vegetation from Big Lagoon — 4 October 1978**

Tremandraceae	*Tetratheca pilosa*
Polygalaceae	*Comesperina volubile*
Rutaceae	*Correa reflexa*
Rhamnaceae	*Pomaderris pilifera*
Leguminosae — Mimosoideae	*Acacia sophorae*
	A. genistifolia
	A. botrycephala
— Papilionateae	*Aotus ericoides*
	Diltwynnia sericea
	D. glaberrina
	Gompholobium huegelii
Haloragaceae	*Haloragis tetragyna*
Myrtaceae	*Calythrix tetragona*
	Baeckea ramosissima
	Melaleuca gibbosa
	M. squarrosa
	Leptospermum scoparium
	Eucalyptus amygdalina
Ficoideae	*Carpobrotus rossii*
Compositae	*Helichrysum scorpioides*
Stylidiaceae	*Stylidium graminifolium*
Campanulaceae	*Wahlenbergia* sp.
Epacridaceae	*Leucopogon ericoides*
	Leucopogon collinus
	Epacris impressa
	E. Lanuginosa
	Sprengelia incarnata
	Styphelia adscendens
	Monotoca elliptica
Polygonaceae	*Muehlenbeckia adpressa*
Lauraceae	*Cassytha melantha*
Proteaceae	*Banksia marginata*
Thymeleaceae	*Pimelea glauca*
	Pimelea linifolia
Euphorbiaceae	*Amperea xiphoclada*
Casuarinaceae	*Casuarina monilifera*
	C. littoralis
Monocotyledons	
Orchidaceae	*Glossodia major*
Cyperaceae	*Lepidosperma gladiatum*
	L. laterale
	Lepidosperma concavum
	Scirpus nodosus
Juncaceae	*Gymnoschoenus sphaerocephalus*
Restiaceae	*Restio complanatus*
	Leptocarpus tenax
	Hypolaena fastigiata
Iridaceae	*Patersonia fragilis*
Liliaceae — Xerotae	*Lomandra longifolia*
— Xanthorrheae	*Xanthorrhea australis*
Gramineae	*Poa* sp. (tussocky)
Lichens	*Cladonia retipora*
Fern	*Pteridium esculentum* Bracken

(Table 1 contd.)

Vegetation from Wet Heathland Habitat at Round Hill — 5 October 1978

Monocotyledons	
Cyperaceae	*Gymnoschoenus sphaerocephalus* *Lepidosperma* sp. *Lepidosperma filiforme* *Baumea* sp. *Tetraria capillaris*
Restionaceae	*Leptocarpus tenax* *Leptocarpus brownii*
Liliaceae — Xerotae	*Lomandra longifolia*
Dicotyledons	
Dilleniaceae	*Hibbertia riparia*
Leguminosae — Mimosoideae	*Acacia genistifolia*
— Papilionateae	*Sphaerolobium vimineum* *Pultenea subumbellata*
Myrtaceae	*Eucalyptus amygdalina* *E. ovata* *Leptospermum lanigerum* *Melaleuca gibbosa* *Melaleuca squarrosa*
Epacridaceae	*Sprengelia incarnata*
Lauraceae	*Cassytha pubescens*
Proteaceae	*Hakea nodosa* *H. teretifolia*
Casuarinaceae	*Casuarina paludosa*
Ferns	*Gleichenia dicarpa* *Lindsaya linearis*
Selaginellaceae	*Selaginella uliginosa*

Males	Number in Sample	Range
Weight	8	28-36
Total Length	8	175-198
Tail	8	73-90

Females	Number in Sample	Range
Weight	10	20.5-29
Total Length	10	170-197
Tail	10	70-80

TABLE 2 Weights (gm) and measurements (mm) of *Sminthopsis leucopis*

Males	Number in Sample	Range	Mean ± Standard Error	Standard Deviation
Weight	59	64-180	124.3 ± 2.7	20.6
Total Length	59	230-305	275.3 ± 3.3	25.3
Tail	59	90-127	114.7 ± 1.0	7.5

Females	Number in Sample	Range	Mean ± Standard Error	Standard Deviation
Weight	62	61-138	97.9 ± 1.8	14.1
Total Length	62	238-297	268 ± 1.7	13.3
Tail	62	96-127	112.9 ± 0.9	6.9

TABLE 3 Weights (gm) and measurements (mm) of *Rattus lutreolus*

Males	Number in Sample	Range
Weight	12	15-21.5
Total Length	11	150-185
Tail	11	73-88

Females	Number in Sample	Range
Weight	5	12-18
Total Length	5	143-167
Tail	5	66-84

TABLE 4 Weights (gm) and measurements (mm) of *Mus musculus*

Trapping was undertaken in heathland ranging from low-lying waterlogged areas (Plate 1) to welldrained sandy ridges and stabilised coastal sand dunes. (Plate 2). Random botanical sampling was undertaken in both wet and dry environment (Fig. 1) and species collected for identification are listed in Table 1.

The wet area sampled lies west of Round Hill and is a drainage basin punctuated with spurs of higher ground which support stunted *Eucalyptus* spp. regrowth. It is subjected to sudden rises in water level when rain falls and water runs from the surrounding hills. At such times up to 20 cm of water may flood the lowest parts of the basin and as there is no outlet except by seepage through the sandy soil to the coast, drainage is relatively slow. The section where small mammal trapping was undertaken had not been burnt for some years, the vegetation in places being up to 2 m high and sufficiently dense for the formation of burrow-like runways beneath the foliage. Subsurface burrows were not formed in this habitat, probably because of repeated flooding.

The dry areas supported a more diverse vegetation with cover ranging from 30 cm to 3 m in height depending primarily upon the time lapse between burns. Runways were prevalent where vegetation was low and dense and in the dry sandy soil extensive burrow systems were formed by Swamp-rats *Rattus lutreolus*. The Cutting Rush *Lomandra longifolia* was a common element of the vegetation in frequently burned areas and its rapid regrowth provides small mammal cover at an early stage. Clumps of this plant were usually found to support the runways of Swamp-rats and subsurface burrows were often formed about the root systems.

METHODS AND SOURCES OF DATA

Mammal collecting was undertaken by sample trapping in a number of sites. Standard commercial rat traps were set on about 1800 trap nights, Sherman tin traps (23 x 9 x 8 cm) on 350 trap nights and wire cage traps (45 x 20 x 20 cm) on 50 trap nights. Traps were placed at 10-20 m intervals and mostly left set for two nights at each site, baited with brown bread spread with peanut butter. Bait was changed each time traps were moved or reset.

When mammals were removed from traps, they were immediately placed in individual plastic bags and chloroform administered to kill ectoparasites and prevent cross infestation. When mammals were processed, the ectoparasites were collected by brushing and shaking them from the pelage onto a sheet of white paper and then preserved in 70% alcohol. Standard measurements were made, the abdomenal cavity of each mammal and reptile opened and breeding condition recorded. One kidney was removed from each mammal and preserved in formol saline for later examination for *Kolossiella* spp., six livers were removed to examine for liver fluke *Fasciola hepatica* and blood samples were taken from four mammals for *Leptospirosis* testing. Vertebrate animals were preserved in 4% formalin. About 50 km of road patrol spotlighting was carried out over three evenings and a watch for bats flying at dusk was undertaken on five evenings. Nomenclature for mammals follows Ride (1970).

Birds were observed and recorded at every opportunity but, except for three Scrubwrens *Sericornis frontalis* accidently caught in snap traps, none were collected. Nomenclature follows Schodde *et al.* (1978).

Reptiles were caught by hand whenever possible but the cool and overcast conditions which prevailed for much of the time resulted in little reptilian activity. Nomenclature follows Rowlinson (1974).

Frogs were recorded by their calling and by the collection of occasional individuals but very little time was devoted to searching for them. Nomenclature follows Littlejohn & Martin (1974).

Because of the relatively short time spent in the area, no attempt was made to assess the degree of species abundance beyond a use of the broad terms uncommon or common. Only those species collected and/or observed are listed and remarks are confined to activity in heathland.

FAUNA LIST

Mammals

Brush Wallaby *Macropus rufogriseus*

Common, visiting the more recently burnt, exposed areas to feed at night. Some hide by day in tall heath and scrub on the dry banks.

Pademelon *Thylogale billardieri*

Common in the tall, dense areas wherever growth is sufficiently advanced to provide cover. In such areas it has formed runways beneath the vegetation from which it ventures at night to feed in adjacent clearings.

Brush-tailed Possum *Trichosurus vulpecula*

Uncommon, probably because of a lack of trees with cavities suitable for diurnal hides in the heathland. Some individuals visit the recently burnt or open areas where grazing is available. Both the black and grey phases are present. It is probably more prevalent in the nearby sclerophyll forest.

Common Wombat *Vombatus ursinus*

Uncommon but generally distributed, hiding by day in the taller dense vegetation and in burrows on the dry sandy banks. It ventures onto the most recently burnt and exposed areas to graze at night.

Tiger Cat *Dasyurus maculatus*

Uncommon, an adult female (weight 2 kg) caught in a cage trap set in dry heathland was found to be heavily lactating with four nipples greatly enlarged and was released after examination.

Quoll *Dasyurus viverrinus*

Uncommon; an adult (black phase) was seen on the roadside when spotlighting near Big Lagoon.

Swamp Antechinus *Antechinus minimus*

Uncommon; one adult female (weight 55 g) was trapped in dry heathland near Big Lagoon. Six of the eight nipples were considerably enlarged and lactating had only recently ceased. The pouch opening was 30 x 30 mm. This represents an extension of the distributional range given by Green (1972) and is the first occasion that the species has been found living in dry heathland. It has also recently been recorded by Green (1979) from rainforest in north-western Tasmania but its preferred habitat appears to be wet sedgeland (Green, 1972). Small, apparently relict areas of sedge (Buttongrass *Gymnoschoenus sphaerocephalus*) persist in the general area but are largely kept burning to a stage where they are unacceptable to *A. minimus*. It appears most likely that this animal represents another instance of a relict population surviving from an earlier, wider distribution which has been reduced progressively by gradually changing climatic and environmental conditions as previously suggested by Green (1972).

Its post breeding condition suggests that the population in this warm, coastal climate breeds very much earlier than populations in the colder highlands where young in the pouch have been recorded as late as December (Green 1972, pl. 22).

White-footed Dunnart *Sminthopsis leucopus*

Common, eighteen were trapped in both wet and dry habitats. It also occurs in dry sclerophyll forest on the surrounding hills as found on a collecting trip in June 1976 when twelve were collected over a range of habitats (unpublished data). The largest male (Table 2) greatly exceeds that given by Green (1973) and males considerably exceed females in both weight and size. This is consistent with sexual differences of weights and body proportions of other dasyurid marsupials (Quoll *Dasyurus viverrinus and* Tasmanian Devil *Sarcophalus harrisii*) from north-eastern Tasmania (Green 1967a). All pouches were undeveloped and by dissections and superficial examination, no animals were found to be pregnant. A female collected at Round Hill on 11 October 1976 had eight pouch young each with a crown-rump length of 8 mm (Green, 1972, 34).

Eastern Swamp-rat *Rattus lutreolus*

Common in both wet and dry heathland and around the edges of swamps and lagoons wherever the vegetation is sufficiently dense to provide shelter. There it forms extensive runways and it burrows freely in the dry sandy soil.

One hundred and twenty-one animals, all fully adult, were trapped. Some measurements are given in Table 3 which shows males significantly exceed females in weight and size. Only one was found to be pregnant, with three embryonic sacs having developed to 6 mm in diameter, one in the left and two in the right uterine horns. This closely fits the date for onset of breeding recorded by Green (1967b). Teste development appeared to be at a peak with scrota greatly enlarged and measuring up to 35 x 25 mm in many rats. Most animals appeared to be healthy, vigorous young rats less than one year old but some of both sexes were obviously aged survivors of the previous generation, living to a second breeding season and in such a state of decline that it would be unlikely they could survive territorial competition from the new generation.

One female was found to be distinctly 'rumpy' with the tips of the fur and guard hairs on the back just above the tail, broken to expose the underfur. This is a common occurrence in the Brush-tailed Possum *Trichosurus vulpecula* (Munday, 1966) but has not previously been recorded in the Eastern Swamp-rat. Skin scrapings for mites and cultures for ringworm fungi both proved negative (B. L. Mundays pers. comm.). One female had a white patch about 20 x 30 mm in extent on the right flank.

New-holland Mouse *Pseudomys novaehollandiao*

Uncommon in the heathland but probably more numerous in the adjacent areas and beneath the stunted *Eucalyptus* spp. regeneration which is believed to be its favoured habitat. Four adult males were trapped within a few hundred metres of each other on the same night in dry heathland north of Big Lagoon where a few regenerating eucalypts had grown to about 5 m in height. The animals were taken on the second night of the set, the first night's catch being only of Swamp-rats.

Another male, collected on 3 June 1976, was trapped on dry leaf litter in an open area beneath scrubby regenerating *Eucalyptus* spp. about 1 km south of the present site. (Unpub. data).

Water Rat *Hydromys chrysogaster*

Uncommon in heathland but more numerous around the swamps, lagoons, drainage systems and coastline. An adult male (weight 594 g, head and body length 543 mm, tail 245 mm) was caught in a cage trap baited with raw fish and set over water in a drainage section of wet heathland.

House Mouse *Mus musculus*

Common in dry heathland; eight females and ten males, all adult, were trapped. None were pregnant or lactating. In most instances testes were undeveloped and inguinal. Two had testes enlarged, their scrota being 10 x 8 mm. Measurements are given in Table 4.

Rabbit *Oryctolagus cuniculus*

Uncommon; favouring the dry sandy ridges and coastal dunes where faeces and diggings were occasionally found.

Little Bat *Eptesicus pumilus*

Uncommon; individuals were seen flying at dusk on several evenings. One bat was shot and found to be an adult male of this species.

Echidna *Tachyglossus aculeatus*

Uncommon; only one adult female (weight 1.6 kg), lacking any sign of recent lactation, was collected in dry heathland.

Birds found living in the heathland

Swamp Quail *Coturnix ypsilophora*

Uncommon; in dry heathland where the vegetation was relatively low and semi-open. Only pairs or individuals were seen.

Masked Lapwing *Vanellus miles*

Uncommon; a party of six found resting on the gravel road through recently burnt heathland south of Big Lagoon were the only birds present.

Green Rosella *Platycercus caledonicus*

Uncommon; up to three occasionally seen in stunted eucalypts growing in dry heathland. Though such habitat is suitable for shelter and feeding, the absence of trees with nesting hollows would force this bird to return to the sclerophyll forest for breeding.

Pallid Cuckoo *Cuculus pallidus*

Uncommon; one found calling from stunted eucalypts in dry heathland and others occasionally from eucalypts bordering the heathland.

Fan-tail Cuckoo *Cuculus pyrrhophanus*

Uncommon; occasionally seen and heard calling from the dry heathland.

Richards Pipit *Anthus novaeseelandiae*

Uncommon; occasional pairs were found in the most recently burnt areas south of Big Lagoon and behind Swimcart Beach. Behavioral activity suggested these birds were nesting.

Black-faced Cuckoo-shrike *Coracina novaehollandiae*

Uncommon; a few sightings of individual birds resting in the stunted eucalypts. All appeared to be recently arrived transitory migrants.

Blackbird *Turdus merula*

Uncommon; only one heard singing from the vicinity of the heathland — dry sclerophyll forest ecotone.

Flame Robin *Petroica phoenicea*

Uncommon at the time of the survey. Several were seen about the dry heathland at Round Hill on 30 September, apparently recently arrived transitory migrants.

Golden Whistler *Pachycephala pectoralis*

Uncommon; an adult female was seen in tall heath and stunted eucalypts near Round Hill on several occasions.

Grey Shrike-thrush *Colluricincla harmonica*
Uncommon; individuals were occasionally seen in stunted eucalypts in dry heathland.

Grey Fantail *Rhipidura fuliginosa*
Uncommon; individuals were occasionally seen feeding above the taller vegetation, mostly about the stunted eucalypts.

Superb Fairy Wren *Malurus cyaneus*
Uncommon; only infrequent pairs were found in the more densely vegetated areas of both wet and dry heathland.

Calamanthus *Sericornis fuliginosus*
Uncommon; individuals were occasionally seen and heard calling in both the wet and dry heathland.

Brown Thornbill *Acanthiza pusilla*
Common throughout the area and often observed searching amongst the foliage of heath.

Yellow Wattlebird *Anthochaera paradoxa*
Uncommon; occasional birds were seen and heard about the taller eucalypts growing on the edge of dry heathland at Round Hill.

Crescent Honeyeater *Phylidonyris pyrrhoptera*
Common throughout the area and regularly heard calling.

New Holland Honeyeater *Phylidonyris novaehollandiae*
Common throughout the area in pairs and small parties.

Tawny-crowned Honeyeater *Phylidonyris melanops*
Common, especially so in the dry heathland and associated clump of stunted eucalypts. Most birds appeared to be breeding and one nest with two eggs hatching was found in short heath behind Swimcart Beach on 5 October.

Eastern Spinebill *Acanthorhynchus tenuirostris*
Uncommon; seen or heard calling occasionally in the vicinity of Round Hill.

Silvereye *Zosterops lateralis*
Common in small parties which appeared to be of nomads or transitory migrants passing through the area.

Beautiful Firetail *Emblema bella*
Common; pairs and individuals were found in the taller heath and stunted eucalypts.

Grey Butcherbird *Cracticus torquatus*
Uncommon in the heathland but common in the adjacent dry sclerophyll forest from which it makes sorties into the heathland to hunt its prey.

Forest Raven *Corvus tasmanicus*
Uncommon in the heath; a pair, apparently nesting in nearby dry sclerophyll forest, occasionally visited the short coastal heath behind Swimcart Beach in search of food.

Birds seen near the heathland

Great Cormorant *Phalacrocorax carbo*
Occasionally seen about the lagoons.

Little Pied Cormorant *Phalacrocorax melanoleucos*
Occasionally seen about the lagoons.

White-faced Heron *Ardea novaehollandiae*
One observed at Big Lagoon.

White-bellied Sea-eagle *Haliaeetus leucogaster*
One seen near Sloop Rock.

Marsh Harrier *Circus aeruginosus*
One observed near Sloop Rock.

Brown Falcon *Falco berigora*
One observed near Big Lagoon.

Pied Oystercatcher *Haematopus longirostris*
Occasionally seen near Big Lagoon.

Hooded Plover *Charadrius rubicollis*
A pair observed on the beach near Big Lagoon.

Silver Gull *Larus novaehollandiae*
A few observed about the beaches and lagoons.

Pacific Gull *Larus pacificus*
A few seen about the beaches and at Big Lagoon.

Crested Tern *Sterna bergii*
A few seen flying over Big Lagoon.

Yellow-tailed Black Cockatoo *Calyptorhynchus lunereus*
Four flying south over the heathland at Round Hill on 26 September and one flying north over the same area on 5 October.

Swift Parrot *Lathamus discolor*
Six flying north at Round Hill at 0730 hours on 3 October.

Blue-winged Parrot *Neophema chrysostoma*
One flying south, high and fast, at 0700 hours on 2 October.

Kookaburra *Dacelo novaeguineae*
Often heard calling in the sclerophyll forest.

Welcome Swallow *Hirundo neoxena*
A few resident pairs around the houses. Several small parties, migrating southwards, flying high and fast at 0900 hours on 26 September.

Tree Martin *Cecropis nigricans*
A few migrating southwards in company with Dusky Woodswallows on 28 September.

White-fronted Chat *Ephthianura albifrons*
Several seen around the shore of Big Lagoon.

Striated Pardalote *Pardalotus striatus*
Often heard calling in the dry sclerophyll forest.

European Goldfinch *Carduelis carduelis*
One flying northwards high above Swimcart Beach on 1 October.

European Greenfinch *Carduelis chloris*
One seen flying over the coastal sand dunes at Big Lagoon.

Common Starling *Sturnus vulgaris*
Parties of up to 30 were seen flying southwards along the coast in the evenings. Similar such parties were flying northwards along the same route in the mornings.

Dusky Woodswallow *Artamus cyanopterus*
Migrating parties of up to 20 were seen flying high in a southward direction on four days, between 26 September and 1 October.

Grey Currawong *Strepera versicolor*
One seen flying over heathland near Round Hill.

Reptiles

Dragon Lizard *Amphibolurus diemensis*
Often seen in the dry heathland. Three males of from 40-57 mm head and body length had teste development of from 5 x 3 to 7 x 4 mm.

Tussock Skink *Leiolopisma entrecasteauxii*
One female collected in dry heathland at the edge of dry sclerophyll forest, 56 mm head and body length, had 5 ovum developed to 4 mm.

Metallic Skink *Leiolopisma metallica*
Two males collected in dry heathland, 40 x 62 mm head and body length, had testes developed to 2 x 1 mm and 5 x 1 mm respectively.

Three-lined Skink *Leiolopisma trilineata*
One sub-adult, 32 mm head and body length, was collected from dry heathland on the edge of dry sclerophyll near Round Hill.

Whites Skink *Egernia whitii*
Often seen in the dry heathland where it forms burrows in the loose soil. One female, collected in dry heathland, 166 mm head and body length, had 9 ovum developed to 1 mm.

Copperhead Snake *Austrelaps suberbus*
A sub-adult female, 426 mm head and body length, was caught in open dry heathland at 0800 hours on an overcast, cool, windy morning.

White-lipped Snake *Drysdalia coronoides*
An adult female, 339 mm head and body length, had six ovum developed to 15 x 10 mm.

Amphibians

Brown Tree-Frog *Litoria ewingi*
A few were heard calling from the wet heathland at night.

Banjo Marsh-frog *Limnodynastes dumerili*
A few were heard calling during the day from small pools in wet heathland near Round Hill.

Yellow-vented Froglet *Crinia signifera*
Many were heard calling at night from drainage areas in the wet heathland near Round Hill.

Tasmanian Froglet *Crinia tasmaniensis*
Many were heard calling at night from drainage areas in the wet heathland near Round Hill.

Sundry Invertebrates

Fleas

A total of 570 fleas were collected from 124 hosts. These have been deposited with Professor Robert Traub, University of Maryland, U.S.A. for taxanomic research.

Helminthes

From *Rattus lutreolus* 29 September and 5 October, S. l. *Hymenolepsis* spp. mesentary larval spiruroid.

From *Malurus cyaneus* 1 October, *Diplotriana*? *tridens*.

From *Sminthopsis leucopus* 29 September, *Tetrabothriostrongylus* ? *mackerrasae*, "*Strongyloides*" sp., amitostomated Trematoda.

ACKNOWLEDGEMENTS

I wish to express my grateful appreciation for the financial assistance and encouragement provided by Professor Robert Traub, University of Maryland, U.S.A., in supporting this field work; and to J. G. Simmons who kindly made available his house at Round Hill for use as a base. Especially I wish to thank J. D. von Stieglitz who worked in an honorary capacity and gave untiringly her support and competent assistance with the field work and the processing of material.

Miss J. L. Gadsby prepared the map and statistics; helminthes were determined by Professor David M. Spratt, Division of Wildlife Research, CSIRO; and the pathological information was provided by Mr. B. L. Munday, Tasmanian Department of Agriculture.

To all, I express my sincere thanks.

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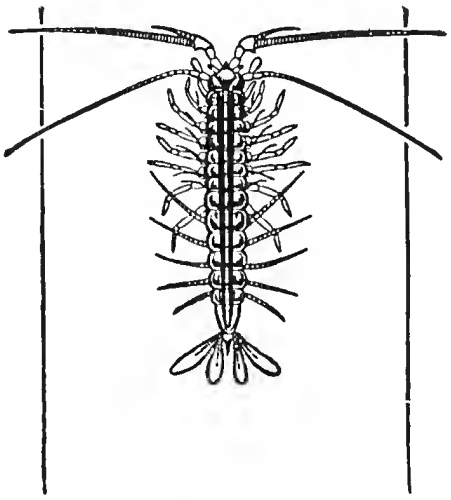
No. 68

RECORDS OF THE QUEEN VICTORIA MUSEUM LAUNCESTON



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C. B. TASSELL
Director of the Museum

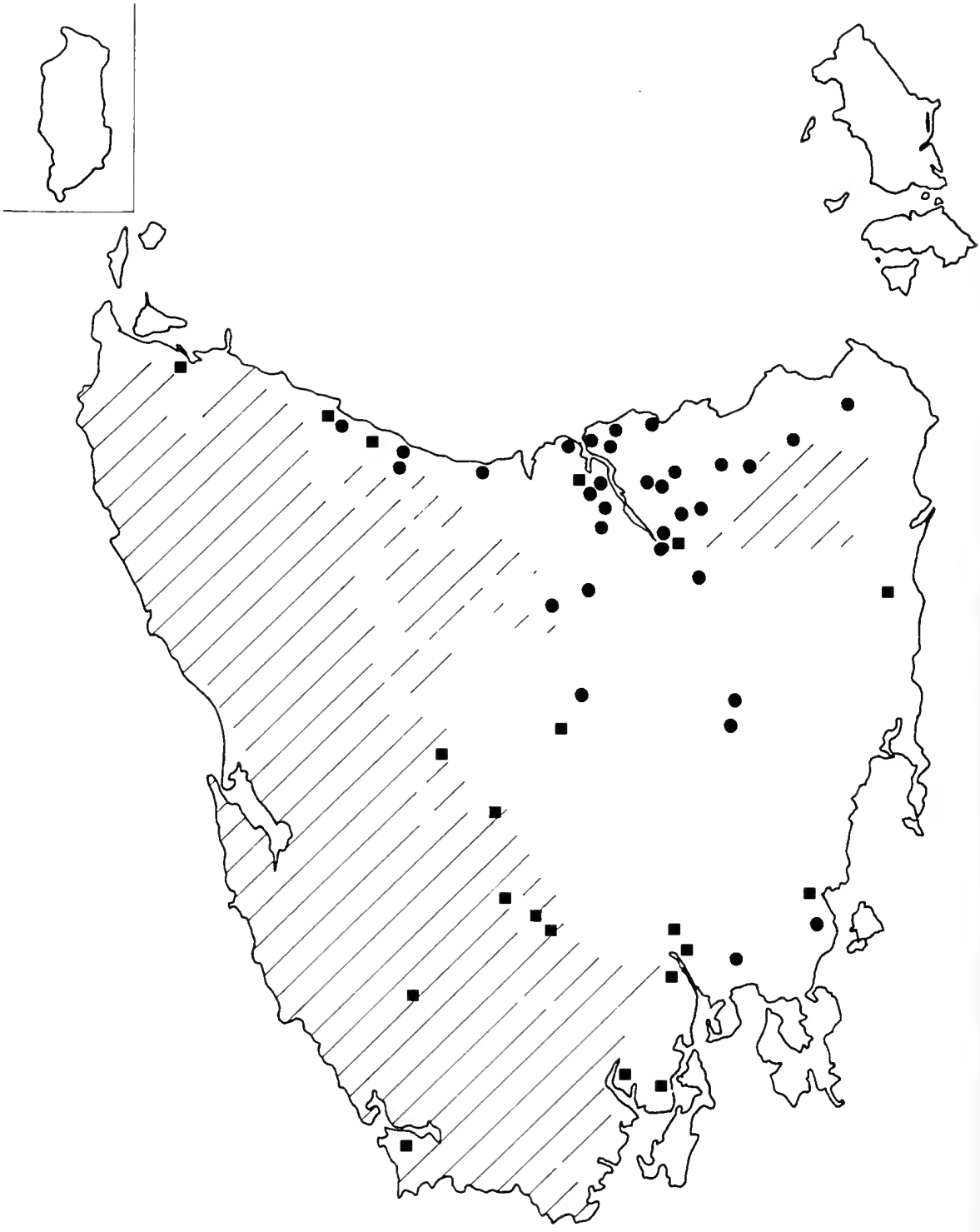

Fig. 1 The distribution of *C. lepidus* based upon specimens in the collections of the Queen Victoria Museum, Launceston (●) and the Tasmanian Museum, Hobart (■). Shades areas (▨) indicate rainforest and sedgeland.

THE LITTLE PIGMY POSSUM
Cercartetus lepidus
IN TASMANIA

by

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Queen Victoria Museum

Manuscript received 30/9/1979 *Published 20/12/79*

INTRODUCTION

The Little Pigmy Possum *Cercartetus lepidus* (Thomas, 1888) was described in "Catalogue of Marsupialia & Monotremata in the collections of the British Museum (Natural History)", having been previously overlooked because such specimens were believed to have been the young of *C. nanus*. The holotype is an alcohol preserved female (skull dried) with four hairless young, one of which has been removed from the pouch (in let. P. D. Jenkins). It was collected in Tasmania (no locality or date given) by Ronald Gunn and presented by him to the British Museum (Nat. Hist.) (Thomas, 1888, pp. 142-143). Wakefield (1963) states that the specimen reached the British Museum in 1852.

Though for many years believed to be confined to Tasmania, *C. lepidus* has now been collected from Kangaroo Island, South Australia (Aitken, 1967), from 46 km south of Pinnaroo, South Australia (Aitken, 1977) and from the Mallee in Victoria (Dixon, 1978). A once wider distribution is evidenced by the discovery of fossil remains in Late Pleistocene deposits from Broom Cave, Wombeyan Caves, eastern New South Wales (Ride, 1960) and sub-fossil deposits from the Pyramids, near Buchan, eastern Victoria (Wakefield, 1960).

Aitken (1974) describes the discovery in 1964 of its existence on Kangaroo Island and compares that population and the habitat in which it lives with the Tasmanian population and its preferred habitat. Turnbull & Schram (1973) discuss the dental morphology of four species of the genus *Cercartetus* and conclude that the inter-specific differences occurring amongst all the living species, as well as morphological variations within the Broom Cave material, strongly supports their being placed in four monotypic genera. However, they concede that a more extensive biological study to test their conclusions is desirable before further taxonomic changes are proposed. Ride (1970, 84-86) places all four within the one genus and Green (1973) follows his arrangement when dealing with the Tasmanian species. Measurements and descriptions of *C. lepidus* are given by Green (1973), Aitken (1974) and Dixon (1978).

Very little biological work has been undertaken on the Little Pigmy Possum. Skemp (1950) gives a popular account and photographs of a captive specimen. Hickman & Hickman (1960) give the results of a twenty-two months study of captives and include data on dormancy periods and diet, Wakefield (1963) summarises the data available to him from museum specimens and other sources, and Green (1973) gives brief notes on habitat preferences, activity, diet and breeding. The present observations are based upon material in the Queen Victoria Museum, Tasmanian Museum and animals kept in captivity for varying periods over the past 18 years.

Plate 1 A nest of *C. lepidus* found beneath a log at Patersonia on 30 September 1967. It was composed of fibrous bark from a *Eucalyptus* sp. and contained two young.

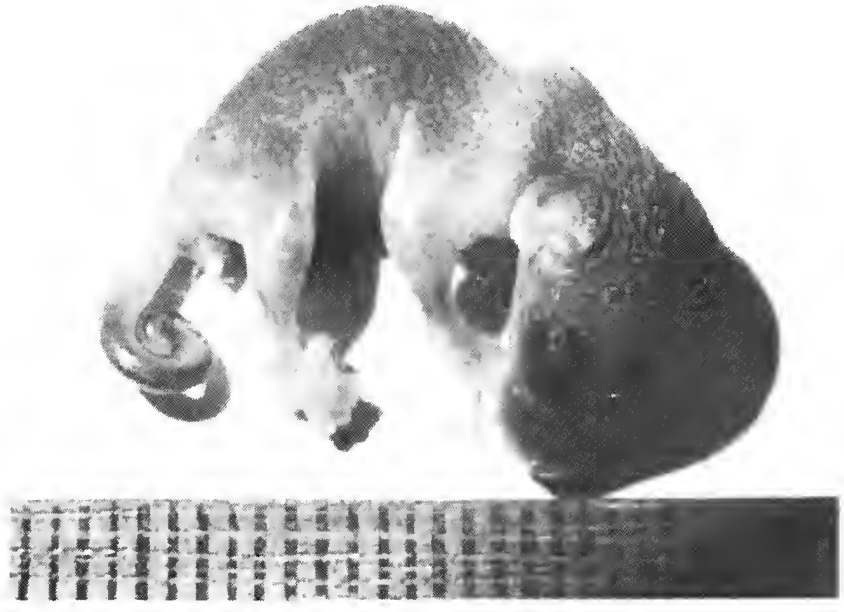

Plate 2 A pouch young of *C. lepidus* (1978/1/53) found at Greens Beach on 29 January 1978. The scale bars are at mm intervals.

TASMANIAN DISTRIBUTION AND HABITAT

The lack of knowledge about trapping *C. lepidus* has resulted in few specimens being collected and then usually by accidental discovery. Most specimens in collections were found by members of the public and taken to museums for identification and donation. This haphazard, opportunistic sampling (Fig. 1) suggests its distribution is restricted to the lowlands of the north, midlands and south. The pattern of distribution in the north follows closely that of the dry sclerophyll forest and woodland but in the south some have been collected in wet selerophyll forest and sedgeland areas. No *C. lepidus* are known to have been found in rainforest and none have been found on the islands around Tasmania. In those areas, it is replaced by the larger *C. nanus* with a little overlap occurring in the wet sclerophyll.

The difficulty in separating sub-adult *C. nanus* from *C. lepidus* has often caused confusion and led to mistaken identifications. Unless otherwise stated, only specimens examined by the author and identified as *C. lepidus* on the criterion of a fourth molar tooth have been included in the distribution map (Fig. 1). The distribution given by Wakefield (1963) includes Bruny Island. This record was probably based on a spirit preserved specimen in the Tasmanian Museum, labelled as *C. lepidus* but which is actually *C. nanus*.

The occurrence of *C. nanus* on Flinders Island (Green 1969) and on King Island (Green & McGarvie 1971), to the exclusion of *C. lepidus*, is consistent with the general pattern of animal distribution. Though the islands presently support a dry habitat, the fauna has a general bias to those species occurring in rainforest and wet selerophyll (Green 1969, Green & McGarvie 1971).

NESTING SITES AND NESTS

Nests and sleeping places of *C. lepidus* are usually close to the ground and often appear to be of a temporary nature. Sites from which it has been collected are beneath overturned turf on ploughed ground, inside decayed logs and stumps, in a small hole in a green tree, amongst the dead needles of a she oak *Casuarina* sp. which had accumulated in twigs about two metres above the ground, in an old nest of a New Holland Honeycater *Phylidonyris novaehollandiae* situated about one metre above ground in dense tea tree scrub, in wall cavities of buildings, in a canvas shower bucket hanging in an outbuilding and amongst old clothes in a shed. In some of these sites, such as that amongst the she oak needles, in the bird's nest, in the hole in the green tree and amongst the old clothes, no nesting material had been gathered and they appeared to be of very temporary usage. The possum found in the bird's nest was a female with four pouch young. The nest was cup shaped and the sleeping possum was sheltered only by the tea tree foliage two metres above. Chaffer (1930) records *C. nanus* nesting in an old nest of *P. novaehollandiae*. Some found asleep in small cavities inside decayed logs have also been without nesting material. Such sites appear to have been used by nomadic individuals without a permanent nest.

Established nests have usually been found to be occupied by two adults. One nest was found to contain two juveniles but the adults and other juveniles may have escaped unnoticed.

Nests examined were found to be composed of strips of fibrous bark. One collected from inside a canvas shower bucket at Greens Beach was merely a lining of small ribbon-like pieces of bark from tea trees. The nearest such trees were about 20 m distant, the possums travelling to and fro along a wire clothes lines stretched between the tea trees and the shed in which the bucket hung. Another (plate 1), collected from beneath a log at Patersonia and containing two juveniles, was a bulky structure in the form of a hollow ball about 10 cm in diameter and composed of bark fibre from *Eucalyptus* sp., much of which had been shredded down to the size of horse hair. A hole in a she oak *Casuarina* sp. near Bridport, from which a single adult had been collected, was found to contain only a few small strands of dry grass matted together by spider webs.

Plate 3 Two young of *C. lepidus* (1975/1/10) with a captive female, not their mother. The young cling tenaciously to the dorsal fur.

Plate 4 An adult *C. lepidus* feeding on a Metallic Skink *Leiolopisma metallica* while holding the lizard in its front feet.

BREEDING AND DEVELOPMENT

Seven sets of alcohol-preserved pouch young are listed in Table 1. Six of these are in the Queen Victoria Museum, collected from localities in central northern Tasmania, and one in the Tasmanian Museum was collected in the south of Tasmania. The following details taken from those specimens are given in ascending order of body size.

Reg. no. 1962/1/4. When cultivating a ploughed paddock on 16th January 1962, two adult *C. lepidus* were disturbed from a nest formed beneath overturned turf. One was caught and passed on to the author the following day. It was found to be a female with noticeable distensions either side of the pouch opening. It was kept in a box and fed on honey and insects but died on 26th January. Upon examination, the pouch was found to contain four young of a mean body weight of 115 mg. They were hairless, the skin being a uniform pale flesh pink and the eyes appearing only as dark rings on the side of the head. The lips at the sides of the mouth were sealed. The front feet were strongly developed and the toes equipped with prominant claws. Sexing was not practicable without risk of damaging the specimens. It is probable that they were born before the female was captured and would therefore be at least ten days old.

Reg. no. 1978/1/53. An adult female, found asleep but not dormant, in the cup-shaped nest of a New Holland Honeyeater on 29th January was carrying four pouch young. In an attempt to rear the young, she was housed in a glass fronted box with sawdust on the floor and equipped with a small nest box in a corner. Syrup, as described later (see "Food") and water were provided. The young were completely enveloped by the pouch and carried in lateral pocket-like expansions formed either side of the opening. Both the female and young were disturbed as little as possible and placed in the nest box on the evening of 29th January.

Upon inspection at 9 a.m. on 30th January, the female was found to be in a dormant state and the four young cast out on the floor of the cage. They were all alive though cold and sluggish and when held in the warmth of cupped hands showed signs of increasing activity. While still dormant the female was held belly uppermost and one of the young placed near the pouch opening. With a little assistance, it was able to re-enter the pouch. The remaining three young were then placed in a cupped hand with the female resting in a normal crouched position on top of them. Within 20 minutes, they had become active and had re-entered the pouch without assistance. By this time, the female had returned to an active state and remained so all day without discarding the young.

At 7 a.m. on 31st January, it was found that food and water had been consumed overnight. The female was in the nest box in a dormant state with all the young still in the pouch. She remained undisturbed and dormant throughout the day.

On the morning of 1st February, it was again found that food and water had been consumed overnight and the female was again dormant but one young had been discarded from the pouch. It was still alive though cold and sluggish but soon became active when warmed in cupped hands. Its body weight was 1000 mg, the dorsal skin dark grey and the ventral skin a pale flesh pink. Under microscopic examination, it was found that dorsal and facial hairs had erupted but ventral hair and vibrissae were not noticeable. The eyes were still closed but the form of the eyelids was obvious. The lips at the sides of the mouth were free and the jaw had full freedom of movement. The ears were still closed. The hind feet were developed equal to the front feet and the claws of both had become elongated. The manus was continually being flexed as if trying to grip. No teeth had erupted. It periodically uttered a series of rapidly repeated low hissing sounds as if distressed or aggravated and it crawled about as if searching for its mother. No attempt was made to return it to the pouch and it was left on the floor of the box near the nest opening after being photographed (plate 2).

At 8.40 a.m. on 2nd February, the young was still on the floor of the box, alive but in a dormant state. Food and water had been taken overnight, two more young had been discarded and the female was found in the nest in a dormant condition.

The first discarded young was then preserved and the second two placed in the nest beneath the female.

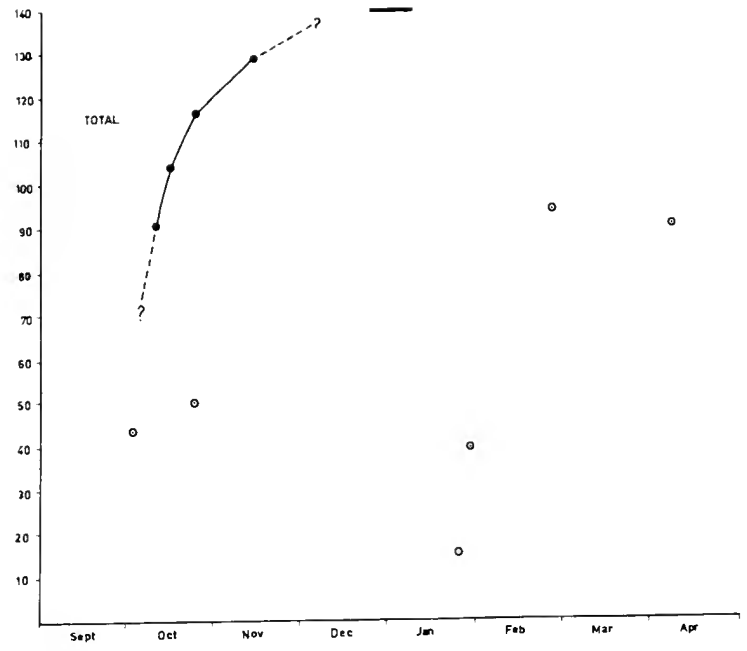

Fig. 2 The mean total length in mm of two young *C. lepidus* (1975/1/9 and 10) measured on four dates between 11 October and 14 November. The mean total length of adults is indicated ▬ The total lengths and dates of collection of six additional sets of young are plotted **O**.

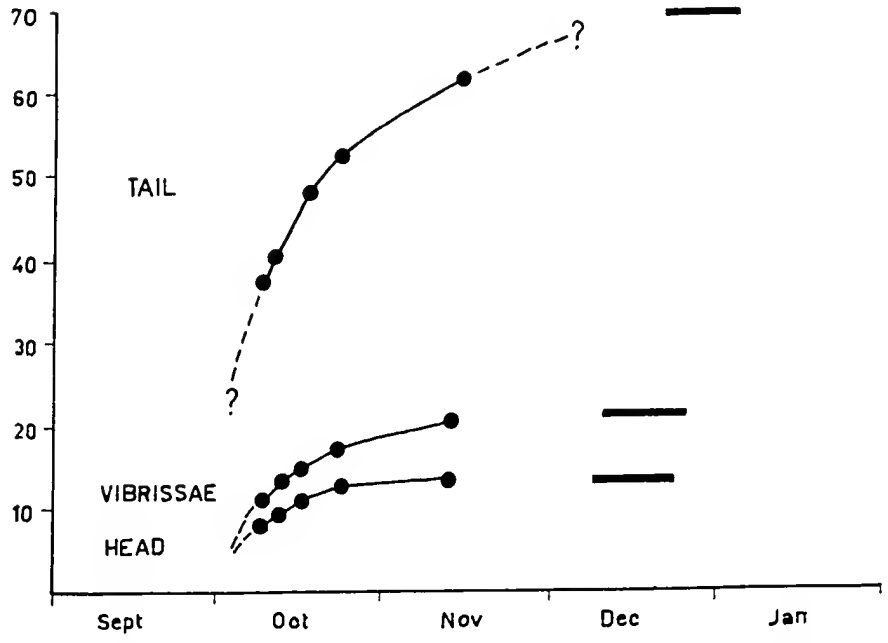

Fig. 3 The mean lengths in mm of tail, mystacial vibrissae and head of two young *C. lepidus* (1975/1/9 and 10) measured on five dates between 9 October and 14 November. The mean of adults is indicated ▬

On the morning of the 3rd February, all three remaining young were found discarded, dead on the floor of the box. It was not known if the young had been able to secure a nipple and feed when returned to the pouch but a body weight of 870 mg of the last discarded individuals, weighed on 3rd February, compared to 1000 mg of that weighed two days previously, suggests a loss possibly due to starvation.

Reg. no. 17754/A55, a set of three in the Tasmanian Museum, was collected at Craddock on 3rd October, 1960. The dorsal fur had just erupted, mystacial vibrissae were to 3 mm and the ears sealed. The eyes were closed and appeared as dark rings and the lips at the sides of the mouth were free. No teeth had erupted.

Reg. no. 1965/1/134. A single specimen, said to have been from a set of three pouch young taken from a female caught in north-eastern Tasmania on 4th October, was presented to the Queen Victoria Museum on 4th May. It had been preserved in alcohol and no other details had been recorded.

Dorsal fur had grown to 0.5 mm and ventral fur had just erupted. Mystacial vibrissae had grown to 8 mm. The eyes were still closed but the ears were open and the lower incisors had erupted.

Reg. no. 1975/1/9 & 10. Two juveniles were found in a nest on the ground beneath a log at Patersonia on 30th September. They were brought to the Queen Victoria Museum on 4th October and were subsequently reared on the prepared diet described later (see "Food"). Measurements of development were recorded at intervals over a period of 34 days. These are plotted in Figs. 2 and 3. When passed to the Museum, the dorsal fur was to 3 mm long, mystacial vibrissae to 9 mm and ears 9 mm. Placed with a captive female *C. lepidus* (not their mother) they clung tenaciously to her dorsal fur and she showed neither intolerance nor maternal response (plate 3).

Reg. no. 1973/1/11. A juvenile collected at Golconda on 8th April had dorsal fur to 7 mm and mystacial vibrissae to 15 mm. The ears were 10 mm and most teeth had erupted.

Reg. no. 1978/1/229. A female and four young (2 male and 2 female) outside the pouch were caught at Deddington on 25th February and kept as pets until death on 25th March. They were then presented to the Queen Victoria Museum. The pouch opening of the adult was elongated, about 10 mm from front to rear and about 5 mm across. The lateral pouch pockets were about 5 mm deep and the nipples were about 3 mm long. The young had dorsal fur to 8 mm long and mystacial vibrissae to 16 mm. The ears were 11 mm and a full set of teeth had erupted in both jaws.

It is accepted that the present data is too sparse to provide definite evidence of seasonal breeding and rate of development. Newly born young are undescribed and age determination of pouch young is not yet possible with reasonable accuracy. However, when the dates of collection and size of the young in the samples are plotted (Figs. 2 and 3), the pattern suggests that *C. lepidus* probably gives birth in the spring or summer months and the young are independent of the pouch by May. The two specimens discussed by Hickman & Hickman (1960) were an adult female without young, collected on 28th April, and an immature female little more than half grown, collected on 12th December. Hickman & Hickman (1960) show that the longest periods of activity in captive animals occurred between September and March. All these data corroborate the breeding times indicated in Figs. 2 and 3.

FOOD

Animals kept in captivity have provided almost all that is known of the diet of *C. lepidus*. Scott (1920) found captives to be fond of the flesh of apple but they disregarded the skin. Hickman & Hickman (1960) found their captives to feed on insects, spiders and small lizards and the weight of food consumed each day during periods of activity to be about seven percent of body weight. They also provided an artificial food on which the animals thrived. It consisted of lightly baked biscuits made from a mixture of self-raising flour (350 g), cornflour (70 g), cane sugar (220 g), salt (1.5 g), milk (20 ml) and one egg.

The present author found *C. lepidus* to readily take a wide range of insects, spiders and small lizards of the genus *Leiolopisma*, securing the prey with its front feet while consuming the pieces (plate 4). It was found to have a fondness for honey and sweet liquids and an artificial supplement which was always available to the animals was made up. This consisted of honey (300 g), sweetened condensed milk (25 g), meat extract (10 gm), and multi-vitamin (2 ml), mixed together with an equal quantity of water to form a syrup. Stock in refrigeration kept fresh for several weeks but when set out in hot weather it fermented and became rancid in a day or so. *C. lepidus*, as well as other species of mammals and birds, has been found to thrive on this supplement but it was sometimes necessary to limit its availability in order to prevent the animals accumulating excessive fat deposits.

In its wild state, *C. lepidus* probably feeds primarily on insects and spiders but its demonstrated fondness for sweet substances suggests that it probably takes nectar when available as well.

ACTIVITY AND DORMANCY

Hickman & Hickman (1960) kept daily records of activity and dormancy for twelve months and found that periods of activity alternated with periods of dormancy throughout the year and that no long hibernations occur, though periods of activity are much longer during the months from September to March than from April to August. The factors which stimulate activity and produce dormancy are unclear and Hickman & Hickman (1960) were unable to find a direct correlation between air temperature and the activity or dormancy of animals.

An adult with four pouch young, captured asleep but not dormant and kept in an empty wooden box overnight, was found to be dormant next morning. No long term records of active and dormant periods have been kept by the present author but observations have shown that, during the winter months, *C. lepidus* is often dormant in the day but becomes active at night as was demonstrated by the taking of food and water. During the summer months, it was often found to be active in the day but rarely was it seen to leave the seclusion of its nest in daylight. Abnormal physical disturbance may also arouse activity but a need to feed seems the most likely stimulant.

PARASITES

Ectoparasites have been collected from the pelage of *C. lepidus* at every opportunity and the following have been identified.

ACARI (mites and ticks)

DERMANYSSIDAE (det. R. Domrow)

Andreaucarus radfordi Domrow, 1963

ARGASIDAE (det. F. H. S. Roberts)

Ixodes tasmani Newmann, 1899

SIPHONAPTERA (fleas)

PYGIOPSYLLIDAE (det. G. P. Holland, D. Mardon)

Acanthopsylla scintilla tasmanica Holland, 1971

Choristopsylla ochi (Roths., 1904)

NATURAL ENEMIES AND HABITAT ALTERATION

There is no direct evidence of predatory pressure on *C. lepidus* but its habitat and mode of living make it vulnerable to some carnivorous predators. These include the feral cat *Felis catus* and Quoll *Dasyurus viverrinus*, both of which live in the areas where *C. lepidus* occurs. The Tiger Cat *Dasyusus maculatus*, though primarily occurring in rainforest and wet sclerophyll forest, occasionally enters adjacent dry sclerophyll forest and would be a potential predator. The small dasyurids do not generally occur in areas where *C. lepidus* lives and are therefore not a threat.

The diurnal seelusion of *C. lepidus* probably proteets it from the diurnal birds of prey but it is no doubt suseeptible to the attaeks of the noeturnally active Masked Owl *Tyto novaehollandiae* and Southern Boobook *Ninox novaeseelandiae*, both of whieh eat small mammals. The Tiger Snake *Notechis ater* and Copperhead Snake *Astrclaps superba* also eat small mammals and probably inelude *C. lepidus* in their diet.

Man's faseination for this tiny marsupial also results in some mortalities when it is aeeidently found, captured and kept as a pet, the unfortunate result of whieh is usually death from malnutrition due to ineorrect diet and housing. Bush fires must also take a toll though this is probably no greater now than before European settlement.

The greatest destruction of the *C. lepidus* population was probably caused by the arrival of European man and his cutting and elearing of the forests to ereate grazing land for domestic stock. This oeeurred largely in the south-east, midlands and noth of the island where dry sclerophyll forest and woodland has been eleared and replaced by extensive areas of open grassland and intensive farming. The present pattern of distribution of *C. lepidus* suggests that a onee eontinuous and unbroken population extended from the south-east to the north eoast but whieh has sinee been fragmented and broken by the removal of mueh of its required habitat and the establishment of grassland barriers.

Unlike the larger marsupials whieh may travel over a relatively wide range, the movements of *C. lepidus* must, because of its diminitive size, be very loealised. Its need to remain within the shelter of its habitat, so the better to avoid the sudden attaeks of predators, prevents it venturing onto grassland to feed as do the larger grazing, earniverous and inseetivorous marsupials which thereby derive some benefits from patches of pasture improvement.

Though it is able to withstand the predatory aetivities of its natural enemies, it is unable to adapt to or in any way benefit from the extensive land elearing aetivities. Until reeently, sueh aetivities have been in general restrieted to the limits of those areas suited to pasture establishment, while still leaving extensive areas of forest not immediately profitable to elear. The reeent handsome financial returns for wood-ehips has stimulated timber harvesting on a scale not previously reached in seope or intensity. This now ereates a further threat to the remaining areas of *C. lepidus* habitat and whieh, with the eontinuing demand for more grazing and agrieultural development must deplete even more the range of this marsupial.

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TABLE 1 Young of *C. lepidus* in the Queen Victoria Museum and young of the holotype in the British Museum (Nat. Hist.).

* estimated

Registered number	Number in set	Length (mm) Total	Tail	Head	Crown rump	Date	Locality
1962/1/4	4	15*	4	5.5	9	26.i.62	Greens Beach
1978/1/53	4	40	10	11.5	17	29.i.78	Greens Beach
17754/A55	3	44	20	11.5	20	3.x.60	Craddock
1965/1/134	3	51	31	12	24	24.x.64	North-east Tas.
1975/1/9&10	2	90	40	?	—	11.x.67	Patersonia
1973/1/11	1	90	49	17	—	8.iv.73	Golconda
1978/1/299	4	94	50	17.5	—	25.ii.75	Deddington
Holotype	4	28	6.5	7	—	N/D	Tasmania

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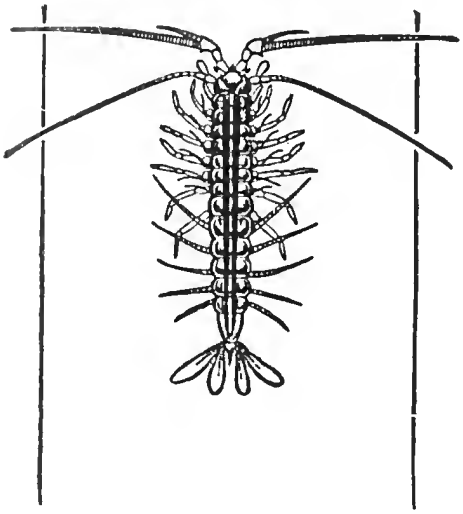

Edited by
C. B. TASSELL
Director of the Museum

FURTHER GASTROPODS FROM THE EARLY DEVONIAN LILYDALE LIMESTONE, VICTORIA

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ABSTRACT

A new genus, subgenus and four species of gastropods are described from the Early Devonian Lilydale Limestone near Melbourne. Eight other gastropod taxa are recorded. Assigned to the family Holopeidae, the new genus *Australonema* is an intermediate form in the *Gyronema-Yunnania* lineage characterized by its shape, sculpture and growth lines. Members of this genus are recorded from the Silurian or Devonian of Victoria, New South Wales and Britain. The new subgenus *Murchisonia* (*Ostioma*), characterized in part by its aberrant gerontic whorls, is recorded from the Devonian of both New South Wales and Victoria. The gastropod fauna described from Lilydale includes *Tropidodiscus* sp., ? *Palaeoscurria* sp., *Australonema australis* (Etheridge), *A. lilydalensis* (Etheridge), *A. melbournensis*, *Anomphalus* sp., ? *Littorinides* sp., *Murchisonia* (*Murchisonia*) sp.A, *M.* (*Murchisonia*) sp.B, *M.* (*Murchisonia*) sp.C, M. (*Ostioma*) *albanicum*, ? *Subulites* (*Fusispira*) sp. Species of the genus *Australonema* from elsewhere in Victoria, New South Wales and Britain, and *Murchisonia* (*Ostioma*) *bloomfieldia* from Taemas near Yass, New South Wales, and the monoplacophoran *Vallatotheca elegantula* (Chapman) from Lilydale are also described.

INTRODUCTION

The gastropod fauna from the Late Siegenian Lilydale Limestone near Melbourne has recently been revised and its age, relationships and palaeoecology discussed (Tassell, 1976). The gastropods described in the present paper are, with two exceptions, previously unknown and represented by only a few specimens. The two exceptions are *Australonema australis* (Etheridge) and *A. lilydalensis* (Etheridge), both originally assigned to the genus *Cyclonema*, albeit with some reservations. Both these species are represented by at least twenty specimens.

The newly described forms considerably increase the known diversity of the Lilydale Limestone gastropod fauna. The presence of species of *M.* (*Ostioma*) at both Taemas near Yass, N.S.W. and Lilydale provides further evidence of the similarity between these two faunas, but the total composition of these two gastropod faunas still differs considerably.

In this study the following abbreviations have been used : P., National Museum of Victoria, Palaeontological Collection; F., Australian Museum, Sydney; A.N.U., Geology Department, Australian National University.

All measurements are in millimetres and the following symbols relating to these measurements have been used : Cl, number of spiral sculptural elements; Hap, height of aperture; Ht., height; L, length; Lap, length of aperture; Sp. A, spiral angle; Wap, width of aperture; Wh, total number of whorls; Wt, total width of shell; *, specimen incomplete.

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THE *Cyclonema* PROBLEM

As currently defined the superfamily Platyceratacea consists of primitively turbiniform gastropods with a prosocline outer lip and, in general, a nacreous inner shell (Knight *et al.*, 1960). These gastropods have been separated into two families, Holopeidae and Platyceratidae.

The family Platyceratidae as presently accepted is composed of Palaeozoic coprophagous gastropods with a predominantly calcitic shell. Throughout their existence from the Middle Ordovician to the Middle Permian, members of this family show progressively greater adaptation to a stationary coprophagous mode of life on crinoids, blastoids or cystoids (Bowsher, 1955). Earlier members are turbiniform to naticiform with a flat columellar lip and irregular prosocline growth lines. Later members tend to uncoil or show other coiling aberrations. The lips of these shells also become uneven while conforming to the irregular surface of the crinoid calyx. Although some of the earlier members of the family possess elements of spiral sculpture, this is progressively lost.

The genus *Cyclonema* Hall is a member of the family Platyceratidae. It is a turbiniform to trochiform gastropod with a polygonal to auriform aperture. It lacks an umbilicus. The sculpture consists of three orders of spiral elements which are cancellated by growth lines, frequently slightly foliaceous and irregular.

The type species, *Cyclonema bilex*, was described by Conrad (1842) from the Late Ordovician Richmond Group, Indiana. Thompson (1970) reviewed the phylogenies proposed for *Cyclonema*. Ulrich (*in* Ulrich and Scofield, 1897) suggested *Gyronema* as a possible stock on the basis of shell morphology. Knight (1934, 1946) suggested *Holopea* as the coiled ancestor of the Platyceratidae. Finally, on the basis of their common coprophagous mode of life and morphological similarities, Bowsher (1955) considered that *Cyclonema* and *Naticonema* were derived from a common (presumably helicoidally coiled) Early or Middle Ordovician ancestor.

Historically the genus *Cyclonema* has been one of the most widely used Palaeozoic gastropod genera. Most medium, turbiniform to trochiform gastropods without a sinus or selenizone, but with prosocline growth lines and numerous elements of spiral sculpture, have been assigned to this genus at some time. These forms range in time from the Middle Ordovician to the Early Carbiniferous. Wide use of the genus led Ulrich as early as 1897 to comment that "We have not had the opportunity to examine any of the Devonian species that are referred to *Cyclonema* by various authors, but judging from the literature alone we feel satisfied that not one has a sufficient right to maintain its position in the genus". Such a situation has continued until the present with Yochelson (*in* Boucot *et al.*, 1960) commenting that "It has long been known that many of the Silurian and Devonian species placed in *Gyronema* and *Cyclonema* have nothing in common with the respective genera except the presence of spiral lirae".

Because of the difficulties in finding valid morphological criteria which would enable the disentanglement of the *Cyclonema* plexus, the use of *Cyclonema in sensulato* has been an acceptable pragmatic solution. However, the continued use of *Cyclonema* in such a broad sense, or rather the continued assignment of all the turbiniform gastropods with a prosoeline outer lip and numerous elements of spiral sculpture, to this genus is not now acceptable. Since Knight *et al.* (1960) revised the superfamily Platyceratacea, the family Platyceratidae is no longer diagnosed on morphological features alone, but also on the coprophagous mode of life which has been largely responsible for the great morphological variations.

In more primitive genera such as *Cyclonema* the influence of such a mode of life was limited because not all species of the genus were coprophagous and those that were may not have been so continuously. Bowsher (1955) illustrated numerous examples of *Cyclonema* sp. attached to the calices of crinoids. Clarke (1921) also described examples of *C. bilex* associated with the crinoid *Glyptocrinus dactylus* Hall. The tegman of this crinoid and the others to which *Cyclonema* has been found attached are relatively smooth. Accordingly, the apertural margins of *Cyclonema* are also relatively smooth. Bowsher (1955) noted "that the magnitude and general configuration of irregularities in the apertural margin of *Cyclonema* agree closely with the slight elevations and depressions of the tegmen of *Glyptocrinus*".

In contrast to the more advanced and specialized members of the family, *Cyclonema* adopted a variety of orientations over the anus of crinoid calices. Such variability has led Clarke (1921) to consider that *Cycloncma* may have been less adapted to a sedentary habit and hence less dependent upon the crinoid than later forms such as *Platyceras*. Fewer specimens of *Cycloncma* are found attached to crinoids and cystoids as compared to the abundance of attached *Platyceras* specimens. The abundance of unattached examples of *Cyclonema* and the variable positions of attached examples has led Thompson (1970) to suggest that *Cyclonema*, although coprophagous, supplemented its diet with algal material scraped from the sea-floor.

An early member of the family Platyceratidae, *Cyclonema* at least in part coprophagous, is characterized by undulatory growth lines consistent with the surface of the crinoid tegmens to which they have been found attached in a variety of positions.

That *Cycloncma* is coprophagous, is undoubted and therefore should be assigned to the family Platyceratidae which is partly defined upon such a mode of life. No longer can the genus be used in the same *sensu-lato* fashion for a type of turbiniform gastropod with numerous elements of spiral sculpture. To do so immediately implies that the gastropod in question also adopted a coprophagous mode of life, even in situations as at Lilydale, where there is a lack of crinoidal material (Tassell, 1976). Therefore *C. lilydalensis* and *C. australis* can no logner be assigned to *Cyclonema* a coprophagous gastropod but rather to a genus in the family Holopeidae. This family as reorganized by Knight *et al.* (1960) is composed of two subfamilies, Holopeinae and Gyronematinae. The former is diagnosed simply as being without or almost without spiral sculptural elements. The latter has spiral sculptural elements which are dominant. Currently seven genera as assigned to the subfamily Gyronematinae. Of these only four, *Antitrochus*, *Yunnania*, *Omphaloncma* and *Cinclindoncma* are turbiniform in shape, with a rounded whorl profile and with numerous elements of spiral sculpture.

Established by Whidborne (1891), the genus *Antitrochus* is characterized by a trochiform shell with numerous (about twenty) spiral sculptural elements. The outer lip, although passing obliquely backwards, is noticeably curved. Importantly, *Antitrochus* is sinistrally coiled, a characteristic which distinguished it from all other genera in the superfamily Platyceratacea. Although sinistral forms are known from the suborder Trochina, for example the recent *Calliostoma incerta*, they are quite rare amongst the Palaeozoic superfamilies of the suborder. As a consequence sinistral coiling is considered to be a significant diagnostic feature.

The *Gyronema-Yunnania* lineage has been discussed by Rollins (in Rollins *et al.*, 1971) when describing *Gyronema lirata* (Hall) from the Middle Devonian, Solsville Member of the Marcellus Formation in New York. Previously the genus has not been reported from strata younger than Silurian age.

G. lirata is a typical member of the genus being of medium size, turbiniform with only a few strong spiral cords and only weak growth lines which are orthocline below the first cord beneath the upper suture. It may also be minutely umbilicate. *Yunnania termicri* Mansuy, the type species, although turbiniform in shape, has a distinctly high spire (a small pleural angle) and numerous spiral sculptural elements. As described it was without an umbilicus. However, Batten (1966) noted that *Y. semicancellata* (de Koninck), from the Lower Carboniferous Hotwells Limestone Somerset, did in some instances possess a minute umbilicus.

Thus in general, the differences between *Gyronema* and *Yunnania* can be restricted to general shell shape and the frequency of spirit sculptural elements, *Yunnania* being higher spired and having more spiral sculptural elements. Rollins (1971) in his discussion concluded "It appears that the *Gyroncma-Yunnania* lineage (Ordovician-Permian) is morphologically close-knit and conservative and it will require study of species populations to make phylogenetic sense of the stock". The suggestion of such a lineage raises the possibility of the existence of intermediate forms having either a large spiral angle and more numerous spiral sculptural elements or a smaller spiral angle and fewer spiral elements.

A possible intermediate is represented by the genus *Omphalonema*, erected by Grabau (1936) for a Permian species from China. This genus is turbiniform with a moderately large spiral angle and numerous elements of spiral sculpture. Knight (1941) in his redescription of the type species, *O. multispiralis* Grabau, described the apertural region as "narrowly phancromphalous; columellar lip seemingly reflected about the umbilicus; parietal inductura thin and seemingly confined to the regions about the base of columella and close to the suture; outer lip seemingly straight with a moderate backward obliquity from the suture downward seemingly without sinus or slit". Knight was unable to examine the original specimens and his redescription was based on Grabau's original description and illustrations.

Subsequently Knight *et al.* (1960) noted bluntly in their generic diagnosis of ? *Omphalonema* that the apertural characteristics were unknown. The lack of information about this critical area in this genus effectively precludes its use as an intermediate member in the *Gyronema-Yunnania* lineage at present.

The genus *Cinclidonema* with a turbiniform shape, reflected columellar lip and sculpture consisting of numerous relatively fine spiral elements and growth lines is very similar to *Omphalonema*. However, it does differ noticeably in the possession of a very distinct shoulder, the nature of the base and details of shape. Even so, Knight (1945) when establishing the genus noted that "It is possible that *Cinclidonema* may find a place in the synonymy of *Omphalonema* when the characters of the genus bearing that name become better known".

The turbiniform gastropods from Lilydale and other areas described in this paper cannot be assigned to the genus *Cyclonema* because of the latter's mode of life and its effect on shell morphology. Nor can they be adequately assigned to any known potential intermediate forms in the *Gyronema-Yunnania* lineage. However, they do belong to a genus whose morphological characters are intermediate between those of *Gyronema* and *Yunnania*; their principal morphological characters being a naticiform to turbiniform shape with numerous frequently coarse elements of spiral sculpture and regular orthocline to prosocline growth lines. These are characters which, in part, do not indicate the adoption of a coprophagous mode of life. This conclusion is further supported by the possession of an operculum in at least one species and the lack of any associated crinoidal remains.

SYSTEMATIC DESCRIPTIONS

Family	TRYBLIDIIDAE Pilsbry in Zittel-Eastman, 1899.
Subfamily	PROPLININAE Knight & Yochelson, 1958.
Genus	VALLATOTHECA Foereste, 1914.

Type species : *Vallatotheca manitoulini* Foerste, 1914; Upper Ordovician; Manitoulin Island, Ontario, Canada.

Vallatotheca elegantula (Chapman), 1916

(Pl. 1, Figs. 18, 19, 21, 22)

1893 *Tryblidium* (*Metophoma*) *nycteis* Cresswell, p. 41, pl. 9, fig. 4 non *Metoptoma nycteis* Billings, 1862.

1913 *Capulus nycteis* (Cresswell); Chapman, p. 227.

1916 *Helcionopsis nyctcis* (Cresswell); Chapman, p. 77, pl. 2, fig. 1.

1916 *Helcionopsis elegantulum* Chapman, p. 77, pl. 2, figs. 2-3, pl. 4, fig. 49.

1959 *Vallatotheca elegantula* (Chapman); Talent, p. 33, figs. 1-4.

Diagnosis : Typical form of genus with short blunt apex, broad anterior basal region and variably developed radial threads.

Description : Medium, sub-ovate, patelliform monoplacophoran with anterior apex overhanging the anterior margin to a variable degree; narrowest anteriorly; short anterior slope weakly concave and overhanging; posterior slope more strongly convex; apex rather blunt; aperture ovoidal; shell moderately thick; no evidence of muscle scars; sculpture composed of strong, protruding, frequently lamellose, concentric lamellae and more variably developed radial threads.

Dimensions :		L	Wt	Ht	Lap	Wap
	P7607	31	20	15	23*	17
	P12834	20	14	10	—	—
	P41765	—	10	6*	—	—
	P41766	19	14	6	—	—
	P41767	36	25*	19*	—	—

Location of Types : 1. *Tryblidium (Metoptoma) nycteis*, National Museum of Victoria. Holotype, P7607.

2. *Helcionopsis elegantulum*. National Museum of Victoria. Holotype, P12834.

Material : Types and 3 other specimens.

Discussion : Comparison between the type species and the Lilydale form reveals few differences. *V. manitoulini* has a sharper apex which projects further anteriorly than that of *V. elegantula*. The Lilydale species has a broader anterior basal region than that of the type species. The concentric sculpture of each species is very similar but the radial threads of the Lilydale form are more variably developed. In the smaller specimens of *V. elegantula* they are typically smaller than those of the type species.

Cresswell (1893) figured and named this species but provided no further details. The specific name chosen by Cresswell had been used previously by Billings (1862) for a form from Canada *Metoptoma nyctcis*. The surface details of the Canadian species were unknown when first described. However, it was figured (figure 39) as possessing concentric lamellae as did the other four species of this genus described by Billings at the same time. Subsequently Whiteaves (1884) reassigned this species to the genus *Tryblidium*. Talent (1959) considered that Cresswell had intended the species from Lilydale to be a new species. As a consequence he considered Cresswell's name a junior homonym.

Chapman (1916) redescribed Cresswell's species and assigned it to another genus. He also established a new species distinguished by its more widely spaced and lamellose concentric ornament and "more evenly rounded dorsum". Furthermore, he observed that the lamellae of *T. (M.) nycteis* at the middle of the shell were 0.5 mm apart whereas those of *H. elegantulum* which is only two-thirds the size were 1.5 mm apart. That Chapman was in fact comparing different growth stages is indicated by the lamellae towards the periphery of *H. elegantulum* having the same spacing as those of *T. (M.) nycteis*. This can be seen clearly in Chapman's figures 2 and 3, plate 1. Talent (1959) figured a specimen with lamellae 0.5 mm apart that are clearly lamellose and concluded that the two species were in fact conspecific. As the two species are conspecific and Cresswell's specific name is a junior homonym, Chapman's specific name is used.

Family BELLEROPHONTIDAE McCoy, 1851.

Subfamily TROPIDODISCINAE Knight, 1956.

Genus TROPIDODISCUS Meek and Worthen, 1866.

Type species : *Bellerophon curvilineatus* Conrad 1842; Lower Devonian; Schoharie, New York.

Tropidodiscus sp.

(Pl. 1, Fig. 25)

Description : Small form of genus with distinct angular dorsal crest; whorl profile gently rounded to nearly flat between angular dorsal crest and edge of umbilicus, then rounds more strongly into umbilicus; umbilici deep and wide; aperture subtriangular with high ridge formed by dorsal crest of preceding whorl on inner lip; inner lip very thin; outer lip passes backwards obliquely from structure to form moderately deep V-shaped sinus culminating at the dorsal crest in a narrow slit that produces a narrow selenizone; shape of outer lip varies slightly throughout growth; narrow convex selenizone raised slightly above former edges of slit; sculpture composed of regular growth lines.

Dimensions :

	L	Wt	Wh
P46910	4.5	1.4	3

Location of Types : National Museum of Victoria. Figured specimen, P46910.

Material : Figured specimen.

Discussion : This species differs from *T. curvilineatus* (Conrad) in being considerably smaller and lacking foliaceous growth lines. Comparison with *T. centrifugalis* (Chapman) from the Lower Devonian sediments at Killara and Loyola, Victoria, is difficult because the latter is poorly preserved. *T. centrifugalis* is considerably larger and appears to have more foliaceous and less regular growth lines. Similarly the poor preservation of *Tropidodiscus* sp.A, and sp.B described by Talent (1963) from the Kilgower Member, Tabberabbera, Victoria, limits comparison. *Tropidodiscus* sp.B while of comparable size lacks other details and, as Talent suggested, may be a juvenile of *Tropidodiscus* sp.A. This latter species differs from the Lilydale species in a number of ways. It is much larger and has finer, less pronounced, but much more closely spaced growth lines.

Superfamily PATELLACEA Refinesque, 1815.

? Family METOPTOMATIDAE Wenz, 1938.

Genus PALAEOSCURRIA Perner, 1903.

Type species : *Palaeoscurria calyptrata* Perner, 1903; Upper Silurian; Kopanina Beds, Butovice, Czechoslavakia.

Discussion : When originally described by Perner (1903) muscle scars were noted as being present in the type species, but Knight (1941) in his redescription could see no evidence for their presence. Consequently Knight *et al.* (1960) in their diagnosis of *Palaeoscurria* noted that the muscle scars were unknown and that it could possibly be congeneric with the Late Palaeozoic genus *Lepetopsis*.

Horny (1961) observed in a specimen of the type species a possible muscle insertion pattern which was short, weak and did not expand into to anterior region of the shell. Although able to identify muscle scars which would distinguish *Palaeoscurria* from *Lepetopsis* he still entertained the idea that they may be congeneric.

? Palaeoscurria sp.
(Pl. 1, Figs. 16, 17)

Description : Moderately small, patelliform gastropod with a probable sub-central apex; anterior profile gently arched; posterior profile moderately concave; aperture probably sub-elliptical; with anterior and posterior ends being more rounded than the sides; basal margin not one plane; posterior margin curved upward slightly; sculpture composed of numerous variably developed concentric growth lines; internal details unknown.

Dimensions :		L	Wt	Ht
	P44068	15*	14.3	9

Location of Types : National Museum of Victoria. Figured specimen P44068.

Material : Figured specimen.

Discussion : The specimen from Lilydale is incomplete. Lacking internal detail no further contribution can be made to the status of *Palaeoscurria*. The external similarity of the Lilydale form and the type species, together with their comparable ages supports the tentative assignment of the Lilydale form to the genus *Palaeoscurria*. Comparison of the Lilydale form is limited, but it does differ from the type species and also Horny's generic diagnosis in its lack of obscure radiating rays or lirae.

Superfamily PLATYCERATACEA Hall, 1859.

Family HOLOPEIDAE Wenz, 1938.

Subfamily GYRONEMATINAE Knight, 1956.

Genus AUSTRALONEMA gen. nov.

Type Species : *Cyclonema australis* Etheridge, 1890; Lower Devonian; Lilydale Limestone, Lilydale, Victoria.

Description : Naticiform to turbiniform gastropods with numerous, closely spaced elements of spiral sculpture; whorls rounded; sutures generally impressed; base rounded; small variably sized umbilicus may be developed; aperture circular to auriform; no apertural emargination; columellar lip reflexed; parietal inductura developed; outer lip orthocline to prosocline from upper suture without irregularities; collabral growth lines developed; sculpture composed of numerous often coarse spiral elements of one or more orders; may possess operculum.

Range : Middle Silurian to Early Devonian.

Distribution : Australia and Europe.

Discussion : *Australonema* can be clearly distinguished from the two end members of the *Gyronema-Yunnania* lineage. It differs from the similarly shaped *Gyronema* in having many more spiral cords which are frequently as strongly developed as those of the end member genus. The higher spired *Yunnania* with its thick shell differs considerably in shape from the more turbiniform *Australonema*.

There appear to be two potential intermediates in the *Gyronema-Yunnania* lineage. Of these *Cinclidonema*, although having sculpture composed of numerous spiral cords and growth lines, can be distinguished from *Australonema* by the development of a distinct shoulder.

The other potential intermediate genus is *Omphalonema*. However, comparison with this genus is severely restricted by inadequate knowledge of the apertural region. At present only known from the Permian of China, *Omphalonema* can be distinguished from *Australonema* by the much weaker development of spiral cords. But just as Knight (1945) considered that *Cinclidonema* may prove to be a junior synonym of *Omphalonema*, so too may *Australonema* if and when more is known of this genus from the Chinese Permian.

The generic name is derived from the presence of numerous strong spiral threads on the southern type species.

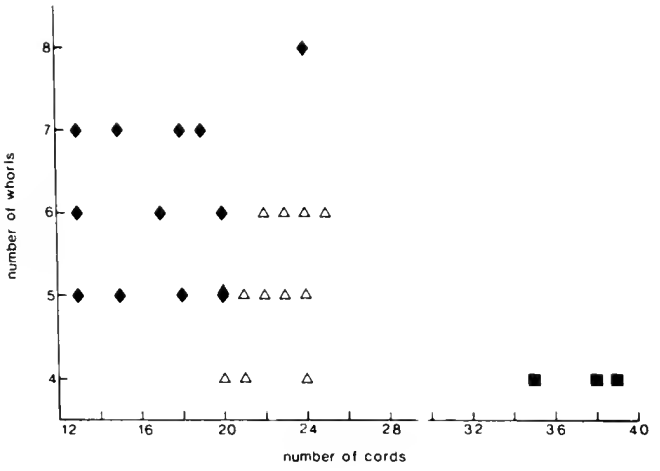


FIGURE 1 Specimens of the three species of *Australonema* from the Lilydale limestone : ◆ *A. australis*, △ *A. lilydalensis*, ■ *A. melbournensis*.

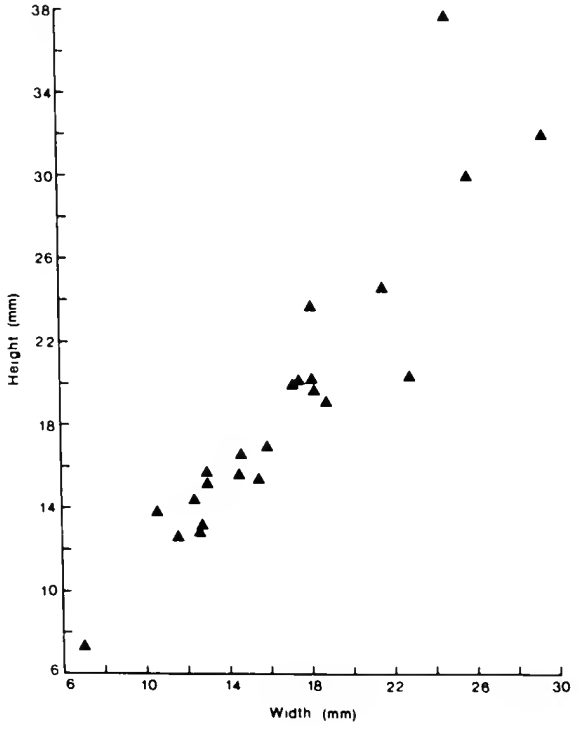


FIGURE 2 *Australonema lilydalensis*, specimens from the Lilydale limestone.

Australonema australis (Etheridge), 1891
(Pl. 2, Figs. 7, 8, 9)

1890 *Cyclonema ? australis* Etheridge, p. 63, pl. 9, figs. 4-5.

1891 *Cyclonema australis* Etheridge, p. 127, pl. 19, figs. 1-2.

1894 *Cyclonema australis* Etheridge, p. 151.

1913 *Cyclonema australis* Etheridge; Chapman, p. 227.

1916 *Cyelonema australis* Etheridge; Chapman, p. 95.

1972 *Cyclonema australis* Etheridge; Yoehelson and Linsley, p. 7.

Diagnosis : Medium turbiniform gastropod with numerous elosely spaced, strong spiral sculptural elements of at least two orders; straight outer lip prosocline; reflexed columellar lip; umbilicus variably developed; growth lines prominent.

Description : Medium turbiniform gastropod with numerous elements of spiral sculpture; whorls gently rounded between impressed sutures; periphery at mid-whorl; base rounded; small, variably developed umbilieus sometimes present; aperture circular; no apertural emarginations present; reflexed columellar lip thiek and excavated; parietal inductura developed; moderately thick outer lip straight and oblique backwards from the upper suture; fine, in places foliaceous, regular, prosocline growth lines; infrequent growth rugae; seulpture composed of two orders of regularly spaced spiral cords; finer elements of seulpture variably developed in early whorls.

Dimensions :

	Ht	Wt	Hap	Wap	Wh	Cl
F.1138	37.4	—	—	—	6	20
F.1251	44.8	29.3	14.8	14.5	6	17
P44069	12.8	9.8	4.9	4.8	5	13
P44070	37.8	29.4	17.2	13.9	7	15
P44071	23.7	25.3	—	—	7	18
P44072	27.6	23.0	10.4	10.6	6	20
P44073	—	—	13.4	13.4	4*	20

Location of Types : Australian Museum. Holotype, F.1138. Paratype, F.1251.

Material : Types and 22 other specimens.

Discussion : The holotype is ineomplete lacking any apertural detail, but the turbiniform shape, prosoeline growth lines and numerous elements of spiral sculpture are all clearly visible.

Comparison of *Australonema australis* with *Cyclonema bilcx* (Conrad) the type species of that genus reveals numerous differenees. The latter species is in nearly all respects more variable than the species from Lilydale. The whorl profile of the more trochiform *C. bilcx* varies from straight to rounded whereas the Lilydale form is always well rounded. The sutures of *A. australis* are impressed while those of *C. bilcx* range from impressed to channelled. The aperture of *C. bilcx* ranges from being distinctly polygonal to rounded. Thompson (1970) noted that the shape of the aperture of *Cyclonema* "is of little taxonomic value because it is influenced by the surfaee of attachment". The form from Lilydale is characterized by a circular aperture. The inner lip of *A. australis* is thick throughout its growth whereas *C. bilex* has an inner lip that is initially thin and which generally thickens with growth. However, there are numerous instances of the inner lip remaining relatively thin throughout growth. While growth rugae do occur on the Lilydale species they are neither as frequent nor as promiment as those found on *C. bilex*. Mueh of the variation that charaeterizes *C. bilcx* is related to the variable shape of the apertural region such as the thickness of the eolumellar lip and the nature of the sutures.

The only feature that remains constant in *C. bilex*, but does vary in *A. australis*, is the presence or absence of an umbilicus. *C. bilex* lacks an umbilicus. Thompson (1970) in her review of the genus *Cyclonema* noted that by definition forms with an umbilicus do not belong to this genus. However, *A. australis* is characterized by a greater variability in the columellar region. Some specimens totally lack an umbilicus, for emample F.1251, whereas others possess a prominent umbilicus, for example P44072.

The American *C. bilex* also differs from the Lilydale species as it possesses a whorl profile with a basal periphery rather than the mid-whorl periphery. The base of *A. australis* is rounded rather than flat as in the case of *C. bilex*... This latter species is also characterized by distinctly prosocline growth lines, which are considerably more irregular and prosocline than those of the species from Lilydale. Besides being larger, *A. australis* has only two orders of relatively coarse spiral sculpture, whereas *C. bilex* typically has three orders of more numerous and much finer spiral sculpture.

Etheridge (1890) when first describing this species from Lilydale, had some reservations about assigning it to the genus *Cyclonema*. He wrote that "It cannot be denied that both this shell and those usually referred to *Cyclonema* by authors, materially differ in appearances from Hall's types of the genus".

Later Etheridge (1891) refined his description of *A. australis* commenting that the spiral ridges were alternately thicker and thinner and that the aperture was circular. He also assigned the species to *Cyclonema* more confidently because the paratype lacked an umbilicus. (It is to be noted that Etheridge's figures of *A. australis* are reversed left to right.)

When first describing *A. australis*, Etheridge commented on the similarity between this species and *Cyclonema carinatum* var. *multicarinatum* from Gotland described by Lindstrom (1884), but still considered *A. australis* to be quite distinct from the Gotland form. Comparison of the Lilydale species with illustrations of that from Gotland reveals numerous similarities including the presence of many elements of spiral sculpture, the presence of an umbilicus, a circular aperture, thickened columellar lip, turbiniform shape and only moderately prosocline fine growth lines. All of these features are suggestive of an assignment to the genus *Australonema*. The Lilydale form can be distinguished from that from Gotland by its larger size and more numerous spiral sculptural elements of two orders.

Australonema lilydalensis (Etheridge), 1891

(Pl. 2, Figs. 4, 5, 6)

1891 *Cyclonema lilydalensis* Etheridge, p. 128, pl. 19, fig. 3.

1894 *Cyclonema lilydalensis* Etheridge, p. 151.

1913 *Cyclonema lilydalensis* Etheridge; Chapman, p. 227.

1916 *Cyclonema lilydalensis* Etheridge; Chapman, p. 94, pl. 5, fig. 38.

1972 *Cyclonema lilydalensis* Etheridge; Yochelson and Linsley, p. 5, pl. 1, figs. 1-4.

Diagnosis : Typical form of genus but with a more globose whorl shape, more numerous spiral sculptural elements and finer growth lines than *A. australis*.

Description : Medium, turbiniform shell with numerous closely spaced elements of spiral sculpture; whorls gently rounded between impressed sutures; periphery at mid-whorl; base rounded; without umbilicus; auriform aperture; no apertural emargintaion; inner lip thin, parietal inductura thin; gently curved columellar lip, initially thin but thickens slightly with age; tendency for columellar lip to become more excavated with age; straight prosocline outer lip, initially thin but thickens with growth; growth lines fine, closely spaced; growth rugae infrequent; sculpture composed of regularly spaced spiral cords.

Discoidal operculum composed of a few anti-clockwise whorls; opercular growth achieved by tangential increments at the operculum rim in the area adjacent to the junction of the parietal and outer lip; operculum nucleus unknown; all remaining whorls visible on the flat to slightly convex external surface; inner edge of whorl exposed in central excentric depression on inner surface; edge of early whorls straight

and vertical but with growth edge becomes rounded and overhangs previous whorls; operculum fits tightly within the aperture; outer edge of the operculum slightly below the outer lip.

Dimensions :

	Ht	Wt	Hap	Wap	Wh	Cl
F1325	31.1	29.3	—	—	5	23*
P44074	16.5	14.8	7.9	7.6	6	24
P44076	24.5	21.6	10.9	13.6	6	25
P44077	19.0	18.9	10.9	10.1	5	23
P44078	31.9	29.3*	17.0	17.9	4	21
P44079	39.5	29.8*	15.4	—	5	20

Locations of Types : Australian Museum. Holotype, F.1325. National Museum of Victoria. Hypotypes, P26888, P26889, P44074.

Material : Types and 34 other specimens.

Discussion : The holotype has been slightly crushed, greatest damage occurring in the apertural region.

Etheridge (1891) considered that this species could be distinguished from *A. australis* on the basis of its more globose whorl shape; finer, more rounded and more numerous spiral cords; more channelled appearance in the areas between the cords; prosocline growth lines which are finer and less prominently developed.

All these features are considered valid in distinguishing *A. lilydalensis* from *A. australis*. The more channelled appearance of the areas between the cords of *A.* lilydalensis arises from the closer spacing of the cords. Because of the relatively small sample of *A. australis* available and the nature of the specimens' preservation it is not possible to separate the two species quantitatively except by the very broadest of characteristics, for example the frequency of spiral cords on the body whorl (see Figure 1).

Chapman (1916) discussed the suggestion that the large numbers of small specimens assigned to this species may in fact belong to a new species. He was able to observe a continuum from the smallest to the largest specimens which can be shown graphically (see Figure 2).

Besides the distinguishing features listed by Etheridge, *A. lilydalensis* can be identified by the spiral sculpture composed of only one order and the absence of an umbilicus.

As with *A. australis*, comparison of *A. lilydalensis* with *C. bilex* reveals numerous differences, many of which arise from the apertural variability of the latter species. The American species has a variable whorl profile ranging from straight to gently rounded with the whorl periphery being at the base of the whorl. *A. lilydalensis* has a well rounded profile with a mid-whorl periphery. The sutures of the Lilydale species are impressed rather than varying from channelled to impressed as does the American species. The aperture of *C. bilex* ranges in shape from polygonal to rounded whereas the Lilydale form is distinctly auriform. The base of *C. bilex* is flattened rather than rounded as in *A. lilydalensis*. This latter species has fine, regular, gently prosoeline growth lines and occasional uncommon growth rugae, but, *C. bilex* has strongly prosoeline growth lines which have a tendency to be irregular. The spiral cords of *A. lilydalensis*, while thinner than those of *A. australis*, are much thicker than those of *C. bilex*. Finally, *A. lilydalensis* has an operculum whose mode of preservation is suggestive of an original aragonite composition (Yochelson and Linsley, 1972). *C. bilex* has not yet been found with an opereulum in place, leading Thompson (1970) to consider that if *Cyclonema* did possess an opereulum it "was probably corneous and thus not preserved".

Yochelson and Linsley discussed the opereulum of *A. lilydalensis*. The only specimen found with an opereulum in place was tentatively assigned to this species by them. Re-examination of this specimen and the holotype confirms their assignment. Subsequently another example of this species with an operculum in place has been found.

Australonema melbournensis sp. nov.
(Pl. 2, Figs. 16, 17)

Diagnosis : Naticiform member of genus with a prominent parietal inductura, numerous elements of spiral sculpture and fewer whorls than *A. australis*.

Description : Medium, naticiform to weakly turbiniform gastropod with numerous closely spaced elements of spiral sculpture; whorls well rounded with mid-whorl periphery; sutures generally impressed but occasionally canaliculate; base rounded and somewhat extended; last whorl expands rapidly; small umbilicus generally present, frequently covered by parietal inductura; aperture auriform; inner lip straight; thickened, reflexed and excavated columellar lip; parietal inductura prominently developed, straight prosocline, outer lip of moderate thickness; fine, frequently foliaceous, regular growth lines present; prominent growth rugae developed; sculpture composed of two or three orders of spiral elements; finest order variably developed.

Dimensions :

	Ht	Wt	Hap	Wap	Wh	Cl
P44081	29.7	27,1	18.5	16.4	4	35
P44082	27.0	22.6	19.6	13.5	4	39
P44083	—	—	20.9	15.5	—	37
P44084	—	36.9	—	—	4	38

Location of Types : National Museum of Victoria. Holotype, P44082.

Material : Holotype and five other specimens.

Discussion : Comparison of *A. melbournensis* with the type species *A. australis* is limited by the few specimens of the former species available. *A. melbournensis* is distinctly naticiform in shape and has fewer whorls than the turbiniform *A. australis*. The type species is characterized by a circular aperture whereas *A. melbournensis* has a distinctly large auriform aperture with a much more extensively developed parietal inductura. This latter species also has many more elements of spiral sculpture than either *A. australis* or *A. lilydalensis* (see Figure 1). The growth rugae of the type species are generally less prominent than those of *A. melbournensis*. Similarly the growth lines of the type species are not generally as foliaceous as those of *A. melbournensis*. As with all other members of this genus there is no evidence of any apertural irregularity.

The diagnoses given by Knight *et al.* (1960) for *Naticonema* and *Platyceras* (*Platyostoma*), the naticiform members of the Platyceratidae, are quite general. In spite of this, comparison of *A. melbournensis* with respective type species reveals numerous differences. Principal of these is the apertural variability of *N. similare* Perner and *P.* (*P.*) *ventricosum* Conrad as evidenced by the growth lines. Both of these species also differ substantially in the nature of their inner lip. *N. similare* although possessing a highly variable aperture lacks the prominently developed parietal inductura of *A. melbournensis*. *P.* (*P.*) *ventricosum* has only a thin inner lip with quite a distinct columellar lip and parietal inductura of greatly varying lengths. As figured by Conrad (1842, pl. 15, fig. 7), the columellar lip is about twice the length of the parietal inductura, whereas Knight *et al.* (1960, fig. 153, 13) illustrated a specimen in which the columellar lip is slightly shorter than the parietal inductura. *N. similare* does have numerous elements of spiral sculpture, but these tend to be finer than those of *A. melbournensis*. The other species, *P.* (*P.*) *ventricosum*, lacks spiral sculptural elements (Boucot & Yochelson, 1966, pl. 3, fig. 21).

Australonema wellingtonensis (Etheridge), 1898
(Pl. 2, Figs. 1, 2, 3)

1898 *Holopea wellingtonensis* Etheridge, p. 77, pl. 15, fig. 11, pl. 16, figs. 7-9.

Diagnosis : Turbiniform gastropod with numerous fine spiral costae of one order; thin, straight, regular outer lip; umbilicus present.

Description : Medium turbiniform gastropod with numerous fine spiral costae of one order; up to six whorls; whorl profile rounded; sutures impressed; periphery at or below mid-whorl; base rounded; narrow umbilicus; aperture sub-circular; arcuate columellar lip thickens towards the thin parietal inductura; straight outer lip thin, regular, prosocline; shell of moderate thickness; fine closely spaced prosocline lines on outer whorl surface continue into the umbilicus; occasional more prominent growth rugae developed.

Dimensions :

	Ht	Wt	Wh	Cl	Sp.A
F.2694	22.0	17.7	6	15	85°
F.2695	—	—	4	8	100°
F.2695a	15.0*	13.7	5	12	81°
F.2695b	13.0*	15*	5	12	—

Location of Types : Australian Museum, Sydney. Syntypes F.2694, F.2695 and F.16939.

Type Locality : Wellington Caves, New South Wales.

Stratigraphic Range : The limestone in which the Wellington Caves occur is considered by Strusz (1972) to be Late Siegenian or Early Emsian.

Distribution : Type locality.

Material : Three syntypes and twelve other specimens.

Discussion : Comparison between *A. wellingtonensis* and the type species *Holopea symmetrica* Hall reveals numerous differences. Most obvious is the absence of spiral sculptural elements and the prominence of the prosocline growth lines of *H. symmetrica* whereas *A. wellingtonensis* has numerous spiral sculptural elements. Although present, the prosocline growth lines of *A. wellingtonensis* are much finer than those of *H. symmetrica*. The umbilicus of the type species is considerably smaller and less pronounced than that of *A. wellingtonensis*. The aperture of this latter species is also less circular than that of *H. symmetrica*.

A comparison between *A. wellingtonensis* and *A. australis* reveals some differences. The type species is typically larger and has more strongly developed spiral sculptural elements of two orders. *A. wellingtonensis* generally has thin lips, as does *A. lilydalensis*, whereas the thickness of the type species lips varies considerably. An umbilicus is developed in *A. wellingtonensis*. The growth lines and sculptural elements of *A. wellingtonensis* have a greater similarity in size and a more delicate appearance than those of any of the Lilydale species.

Specimen F.16939 differs in the nature of its sculpture from the other two syntypes and all other specimens studied. Although the sculpture is still dominated by spiral elements, these are less numerous, more widely spaced and more strongly developed. Whether this variation can be accounted for by natural variation in the species is not yet known.

In his discussion, Etheridge (1898) synonymized an unnamed shell figured by Ratte (1885). These figures show a turbiniform shell with numerous elements apparently of one order and a rounded aperture. The development of the sculptural elements and collabral growth lines is comparable to that found on *A. wellingtonensis*. However, the parietal lip is greatly extended over the umbilical region and to a lesser extent so is the columellar lip. Although illustrated there is no discussion about the shell by Ratte. No other specimens with such features have been observed.

Chapman (1913) noted the presence of *Holopea wellingtonensis* in the sediments at Broadhurst's Creek near Kilmore and Anderson's Creek near Warrandyte in Victoria. The specimens P1075-P1079 upon which the determination for Broadhurst's Creek were made are all poorly preserved in siltstone. Only one specimen (P1075) bears the slightest resemblance to *A. wellingtonensis*. Although smaller in size this specimen is turbiniform in shape with numerous elements of spiral sculpture and may possibly have possessed an umbilicus. However, no apertural details are preserved. The assignment of this specimen to *A. wellingtonensis* is questionable.

Specimens P1076 and P1077 are internal and external moulds of a small turbiniform gastropod which appears to lack spiral sculptural elements except for two bordering a gently concave pseudoselenizone at mid-whorl. Neither species could be assigned to *A. wellingtonensis*.

The remaining specimen P1079, an internal mould lacks all detail and is only identifiable as a gastropod. There is evidence for burrowing activity within the sediment forming the mould. Chapman's assertion that *A. wellingtonensis* is present in these sediments of Silurian age is on the most tentative of evidence and until further material is available should be discounted.

Australonema sp. A
(Pl. 2, Figs. 14, 15)

Description : Medium turbiniform gastropod with numerous elements of spiral sculpture; whorls gently rounded between impressed sutures; mid-whorl periphery; base rounded; aperture sub-ovoidal to polygonal; no apertural emargination present; reflexed thickened columellar lip; outer lip moderately thin; fine growth lines visible on upper half of whorl; growth lines prosocline to very weakly prosocyrt; occasional growth rugae; sculpture composed of two orders of spiral elements.

Dimensions :		Ht	Wt	Cl
	P40531	29.6*	31.1*	14

Location of Types : National Museum of Victoria. Figured specimen, P40531, J. Mushen Collection.

Stratigraphic Range : Wenlockian.

Distribution : Dudley Shale (now included in the Wenlock Shale, (Hurst, 1975)) near Dudley, Britain.

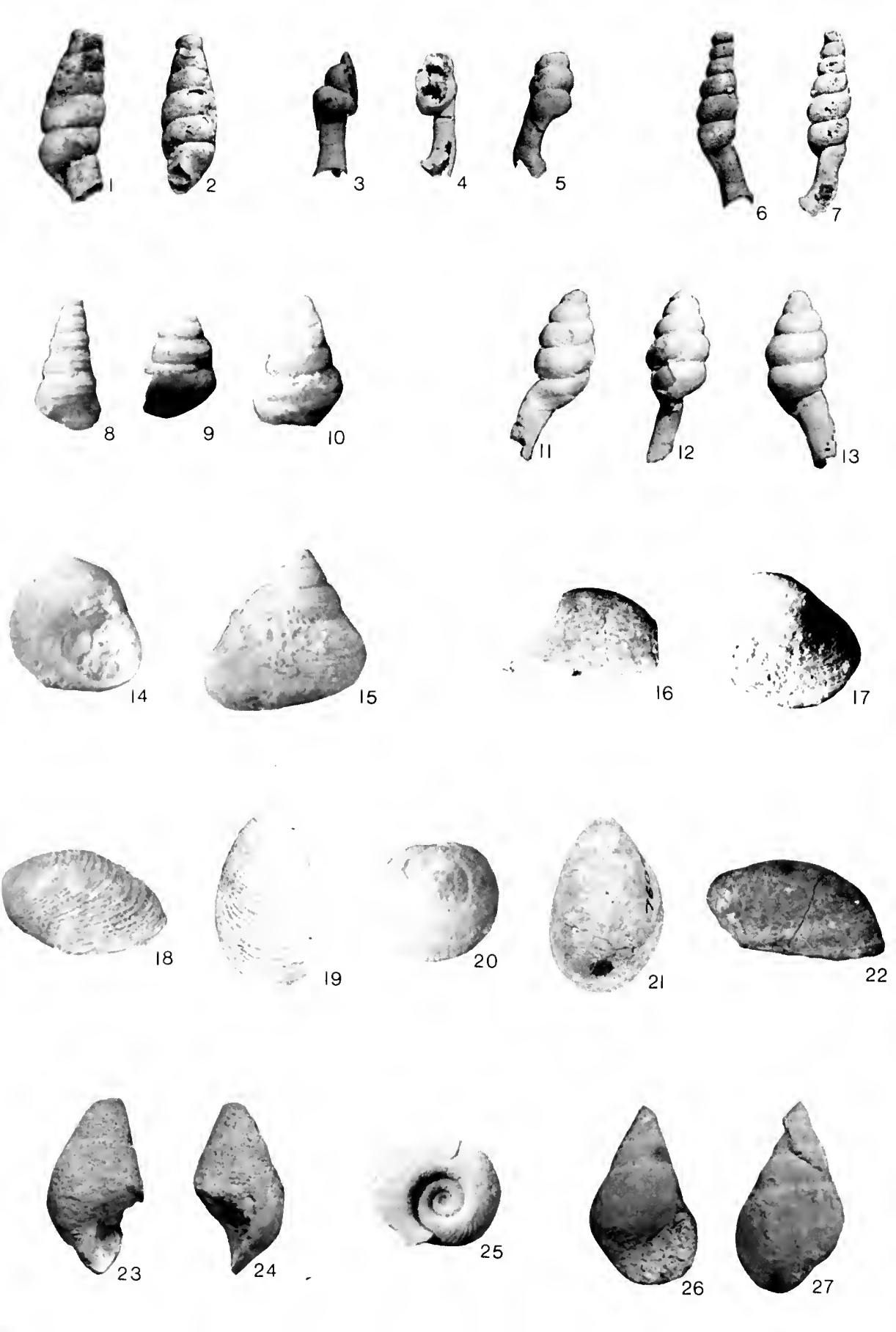
Material : Figured specimen.

Discussion : This specimen was identified as *Murchisonia lloydi* in the catalogue accompanying the Mushen Collection. As originally described by Sowerby *in* Murchison (1839), this species was assigned to the genus *Pleurotomaria*. Subsequently Murchison (1854) assigned it to the genus *Murchisonia*. Comparison of the specimen P40531 with the illustrations in Murchison's work reveals few similarities. Certainly no selenizone is developed in this specimen.

Comparison with *A. australis* is limited by the lack of material. The type species is higher spired and has a more rounded aperture and possibly a thicker outer lip than *Australonema* sp. A which also has finer and more numerous spiral elements developed between the coarser elements.

PLATE 1

Figs. 1-2 *Murchisonia (Ostioma) bloomfieldio* (sp. nov.), ANU 36855, paratype, Bloomfield near Yass, N.S.W., x2½.
Figs. 3-5 *Murchisonio (Ostiomo) bloomfieldio* (sp. nov.), P47533, paratype, Bloomfield near Yass, N.S.W., x2.
Figs. 6-7 *Murchisonia (Ostioma) bloomfieldio* (sp. nov.), P47532, holotype, Bloomfield near Yass, N.S.W., x2.
Fig. 8 *Murchisonio (Murchisonio)* sp. C, P46490, Lilydale, Victoria, x6.
Fig. 9 *Murchisonio (Murchisonio)* sp. B, P46939, Lilydale, Victoria, x10.
Fig. 10 *Murchisonia (Murchisonio)* sp. A, P44086, Lilydale, Victoria, x8.
Figs. 11-13 *Murchisonia (Ostiomo) olbonico* (sp. nov.), P28720, holotype, Lilydale, Victoria, x3.
Figs. 14-15 ? *Littorinides* sp., P46938, Lilydale, Victoria, x5.
Figs. 16-17 ? *Poleoscurria* sp., P44068, Lilydale, Victoria, x2.
Figs. 18-19 *Vallototheca elegantulo* (Chapman), P12834, holotype, Lilydale, Victoria, x1½.
Fig. 20 *Anompholus* sp., P46937, Lilydale, Victoria, x5.
Figs. 21-22 *Vallototheco elegantulo* (Chapman), P7607, holotype, Lilydale, Victoria, x1.
Figs. 23-24 ? *Subulites (Fusispiro)* sp., P1095, Lilydale, Victoria, x2.
Fig. 25 *Tropidodiscus* sp., P46910, Lilydale, Victoria, x5.
Figs. 26-27 ? *Subulites (Fusispira)* sp. P42051, Lilydale, Victoria, x1½.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Australonema sp. indet.
(Pl. 2, Figs. 10, 11)

Description : Medium turbiniform gastropod with numerous fine spiral costae of one order; at least four whorls; whorl profile rounded; sutures probably impressed; periphery at about mid-whorl; base rounded, apertural region largely unknown; outer lip of moderate thickness; growth lines unknown; possible occasional growth rugae.

Dimensions :		Ht	Wt	Wh	Cl
	F.23275	14*	26*	3+	16*
	F.23449	19*	27*	4+	17*

Location of Types : Australian Museum, Sydney. Figured specimens F.23275 and F.23449.

Type Locality : Quidong, New South Wales.

Stratigraphic Range : Ludlovian.

Distribution : Type locality.

Material : Two figured specimens.

Discussion : Both the available specimens are poorly preserved, lacking all apertural details. The appearance of the spiral costae in this species is very similar to that of *A. lilydalensis*. The lack of growth lines in this species would distinguish it from all the other known members of this genus, but their absence may well be a result of poor preservation.

? Australonema sp. A
(Pl. 2, Fig. 12)

1918 *Holopea wellingtonensis* Etheridge; Chapman, p. 218, (In part).

Description : Medium, turbiniform gastropod with whorls gently rounded between impressed sutures; periphery at mid-whorl; base rounded; narrow umbilicus; aperture poorly known; no apertural emargination; columellar lip probably thin and gently curved; outer lip thin and prosocline from the upper suture to the base; fine, closely spaced growth lines developed; numerous weakly developed growth rugae, sculpture composed of fine closely spaced spiral cords; sculptural elements possibly of two orders; growth lines and sculptural elements of same size form a reticulate pattern over the entire whorl surface.

Dimensions :		Ht	Wt	Wh	Cl
	P1075	10.6*	11.5	2*	—
	P44085	16.4*	22.2*	5*	45

Location of Types : National Museum of Victoria. Figured specimen P44085.

Stratigraphic Range : Late Silurian to Early Devonian.

Distribution : Symes Quarry, Killara and Geological Survey of Victoria locality Bb 18, Broadhurst's Creek via Kilmore.

Material : Figured specimen and one other specimen.

Discussion : This species more closely resembles *A. wellingtonensis* than any of the species from Lilydale in both its shape and sculpture. But unlike *A. wellingtonensis* which has spiral elements that are slightly more developed than growth lines both the spiral elements and the growth lines of this species are of comparable size. The result is a sculptural pattern quite different in appearance. Other comparisons are limited by the preservation and lack of specimens of the form from the Victorian mudstones.

The specimen P1075 discussed by Chapman (1913) is assigned to this species because of the frequency of growth rugae. Whether ? *Australonema* sp. A represents a new species or is simply a variant of *A. wellingtonensis* is not known.

? Australonema sp. B

(Pl. 2, Fig. 13)

Description : Medium, turbiniform gastropod with numerous elements of spiral sculpture; whorls rounded between impressed sutures; periphery at mid-whorl; prominent very gently rounded shoulder developed; base rounded; umbilical region unknown; aperture unknown; moderately thick outer lip straight, regular and gently prosocline; fine foliaceous growth lines which in later growth stages are retroussé across certain of the spiral sculptural elements; variably spaced spiral sculptural elements of one order.

Dimensions :		Ht	Wt	Wh	Cl
	F.27860	—	16	3+	10+
	F.30139	18	25	4	—

Location of Types : Australian Museum, Sydney. Figured specimen F.27860.

Type Locality : Specimen F.27860 was collected at Bowning near Yass, while F.30139 was collected at Hattons Corner, near Yass, New South Wales.

Stratigraphic Range : Ludlovian.

Distribution : Yass Basin, New South Wales.

Discussion : Both specimens are poorly preserved. Specimen F.27860 has been severely crushed and distorted, but the sculpture can still be clearly seen. In contrast the uncrushed F.30139 has been much abraded. Such poor preservation prevents useful comparison with the similarly aged and equally poorly preserved *Australonema* sp. indet. from Quidong. The most apparent difference between the Yass and Quidong forms is the presence of retroussé growth lines in places on specimen F.27860. Whether specimen F.30139 possessed such growth lines is not known, certainly none are now apparent. The significence of such a feature and the taxonomic position of the gastropods from the Yass Basin is dependent upon the study of better preserved material.

Superfamily ANOMPHALACEA Wenz, 1938.

Family ANOMPHALIDAE Wenz, 1938.

Genus ANOMPHALUS Meek and Worthen, 1867.

Type Species : *Anomphalus rotulus* Meek and Worthen, 1867; Upper Carboniferous; St. David's Limestone, Hodge's Creek, Illinois, U.S.A.

Range : Early Devonian to Late Carboniferous. The presence of a species of this genus at Lilydale extends the lower limit of its range from the Middle Devonian to the Early Devonian.

Discussion : The occurrence at Lilydale of a species of this genus extends its already wide distribution to include Australia.

Anomphalus sp.
(Pl. 1, Fig. 20)

Description : Small, rotelliform gastropod with whorls strongly embracing above; whorl profile gently convex on upper and lower whorl surfaces; more strongly rounded periphery at mid-whorl; base gently rounded; umbilicus either lacking or covered by thick callus; aperture sub-ovoidal; short columellar lip greatly thickened and strongly oblique outward; parietal inductura moderately thick outer lip orthocline from upper suture to periphery where it becomes distinctly opistocline across the base to the edge of the callus; extensive callus involving columellar lip developed on base; no sculpture except for fine growth lines.

Dimensions :		Ht	Wt	Wh
	P46937	4.4*	6.4*	4

Location of Types : National Museum of Victoria. Figured specimen, P46937.

Material : Figured specimen.

Discussion : Although only one specimen of the Lilydale species is known, it is sufficiently well preserved to warrant comparison with the type species *A. rotulus*. Both species are of comparable size, but *A. rotulus* has a considerably lower spire and more gently rounded whorl profile. The callus of *Anomphalus* sp. is much greater in extent than that of the type species. The callus of the Lilydale species is comparable with that of *A. helicinaeformis* (Schlotheim), the type species of the genus *Antirotella* which Knight *et al.* (1960, p. I144) synonymized with *Anomphalus*.

Superfamily NERITACEA Rafinesque, 1815.

? Family PLAGIOTHYRIDAE Knight, 1956.

Discussion : The presence at Lilydale of a member of this family extends its known distribution and range. Previously it was confined to Europe and ranged from the Middle Devonian to the Early Carboniferous.

Genus LITTORINIDES Knight, 1956.

Type Species : *Littorina solida* de Koninck 1843; Lower Carboniferous; Visé, Belgium.

? Littorinides sp.
(Pl. 1, Figs. 14-15)

Description : Small turbiniform gastropod with numerous elements of closely spaced spiral sculpture; whorl profile gently rounded to nearly flat between impressed sutures; periphery below mid-whorl; base rounded; umbilicus lacking; aperture sub-ovoidal; moderately thick outer lip, straight and oblique backwards from the upper suture; columellar lip broad, thickened and extending medially into the aperture as a toothlike projection; parietal lip thin or absent; fine prosocline growth lines present; sculpture composed of spiral elements which tend to be more widely spaced at mid-whorl.

Dimensions :		Ht	Wt	Hap	Wap	Wh
	P46938	6.6	6.0	4	2	5

Location of Types : National Museum of Victoria. Figured specimen P46938.

Material : Figured specimen and possibly one other specimen.

Discussion : The Lilydale specimen which is figured is extremely well preserved and clearly shows the apertural features. Comparison with *L. solidum* (de Koninck) reveals some differences. The smaller Lilydale form has a more turbiniform shape than *L. solidum* which has a columellar inductura with a straighter outer edge. The result is a wider columellar inductura over its entire length. The columellar inductura of the Lilydale form is distinctly crescentic in shape with the maximum width being at the same point as the maximum width of the toothlike projection. The parietal inductura of *L. solidum* is more strongly developed than that of the Lilydale species.

The Lilydale speeies, represented as it is by enly one speeimen of value, is only tentatively assigned to this genus whieh is known only from the Early Carboniferous of Europe. If the assignment is va id it will extend the known range and distribution of the genus.

Superfamily MURCHISONIACEA Koken, 1896.

Family MURCHISONIIDAE Koken, 1896.

Genus MURCHISONIA D'Archiae & DeVerneuil, 1841.

Subgenus MURCHISONIA (MURCHISONIA) D'Archiae & DeVerneuil, 1841.

Type Speeies : *Murieites turbinatus* Sehlotheim 1820; Middle Devonian; *Stringoeephalus* limestone, near Gladbaeh, Germany.

Diseussion : The only previously deseribed speeies of this subgenus from the Lilydale Limestone is *M.* (*M.*) *pritchardi* (Ethcridge). This species is of moderate size and possesses a distinctive spiral sculpture. The three new species described here are based on a very limited sample. In view of the great morphological variation of Devonian murehisoniid speeies it is possible that all the small Lilydale murchisoniid specimens may belong to the samc variable speeies. They are all considerably smaller than *M.* (*M.*) *pritehardi* oceurring in the same limestone.

Murchisonia (Murchisonia) sp. A

(Pl. 1, Fig. 10)

Deseription : Small, high spired gastropod with a distinct selenizone between two prominent eords at the sub-angular periphery; whorl faees flat above and below the selenizone; sutures moderately deep; base and apertural region unknown; no growth or sculptural lines present; relatively wide, strongly concave selenizonc.

Dimensions :		Ht	Wt	Wh
	P44086	3.2	2.2	6*

Loeation of Types : National Muscum of Vietoria. Figured specimen P44086.

Material : Figured specimen and one other speeimcn.

Diseussion : This species is considerably smaller than the type speeies. Other eomparisons are limited by the few Lilydale speeimens available.

Murchisonia (Murchisonia) sp. B

(Pl. 1, Fig. 9)

Description : Small high spired gastropod with a relatively narrow selenizone bordered by two prominent spiral cords at the sub-angular periphery; upper spiral cord is in turn bordered by a distinet depression; whorl faecs flat above and below the selenizone; sutures prominent; base and apertural regions unknown; only collabral sculpture above the selenizone present; gently prosocline collabral lines of moderate thickness; selenizone eoncave.

Dimensions :		Ht	Wt	Wb
	P46939	2.2	1.5	6*

Location of Types : National Museum of Victoria. Figured spccimen P46939.

Material : Figured speeimen.

Diseussion : This form ean be distinguished from *M.* (*Murchisonia*) sp. A by the presenee of collabral lines above the selenizone, a narrowcr selcnizone and a depression above the upper spiral eord bordering the selenizone.

Murchisonia (Murchisonia) sp. C
(Pl. 1, Fig. 8)

Description : Small, slender high spired gastropod with a shallow selenizone bordered by two spiral cords at angular periphery; whorl face flat to gently convex above and below selenizone; base rounded; aperture sub-circular; columellar lip reflexed, otherwise unknown; parietal inductura absent; outer lip thin otherwise unknown; no growth lines or sculpture present; selenizone gently concave.

Dimensions :		Ht	Wt	Wh
	P46940	4.6	2.3	6

Location of Types : National Museum of Victoria. Figured specimen P46490.

Material : Figured specimen.

Discussion : This form can be readily distinguished from the previously described species by its smaller apical angle, more slender habit, and the more subdued cords bordering the shallower selenizone.

Subgenus MURCHISONIA (OSTIOMA) subgen. nov.

Type Species : *Murchisonia (Ostioma) bloomfieldia*; Lower Devonian; "*Receptaculites*" Limestone, Bloomfield property, Taemas near Yass, New South Wales.

Diagnosis : Moderately small high spired gastropods with a selenizone that changes with growth and a disjunct moderately straight final growth stage.

Description : Small, high-spired gastropods with gently rounded whorls; mid-whorl periphery; base in ephebic stage well rounded; ephebic stage with a shallow broad sinus below periphery that culminates in a slit that gives rise to a slightly elevated selenizone; gerontic whorls uncoiled, disjunct; gerontic aperture round; growth rugae developed.

Discussion : The general appearance of the ephebic stage of this subgenus is somewhat similar to *Murchisonia (Hormotoma)*. However, the Australian form differs from *M. (Hormotoma)* in being smaller, possessing a sinus that changes with growth and a selenizone that is raised above the whorl surface.

During the Early and Middle Devonian there evolved a number of bizarre shaped and sculptured murchisoniaceans. These include the Early Devonian *Lodanaria* (Dahmer) with its widely expanded aperture in the gerontic stage; the Middle Devonian *Brilonella* Kayser which is relatively low spired until the final whorl turns upwards and backwards so that the aperture faces backwards; *Crenulazona* Linsley, a Middle Devonian form which exhibits a progressive change in the nature and character of its selenizone throughout growth. Some Early and Middle Devonian species of *Murchisonia* also exhibit comparatively outlandish shapes and sculptural features.

The occurrence of a species of *Murchisonia* in Australia during the Early Devonian exhibiting bizarre features is not unexpected. Although the subgenus *M. (Ostioma)* is at present represented by only a few specimens, it is felt that their distinct ephebic and gerontic appearance together with their occurrence in two widely separated units of limestone of different ages justifies the establishment of the new subgenus.

The subgeneric name is derived from the distinctive nature of the aperture.

Murchisonia (Ostioma) bloomfieldia sp. nov.

(Pl. 1, Figs. 1-7)

Diagnosis : Moderately small, high spired gastropod with selenizone and disjunct moderately straight final growth stage.

Description : Moderately small, high spired gastropod with gently rounded whorls between impressed sutures; periphery at mid-whorl; nucleus unknown; base at ephebic stage well rounded; aperture at ephebic stage poorly known; outer lip with a broad sinus; narrow selenizone at mid-whorl periphery developed; ephebic stage outer lip continues onto gerontic disjunct whorl(s) for only a short distance; subsequently outer lip of gerontic stage orthoclinc; aperture of disjunct growth stage circular and flared; inner and outer lip of gerontic growth stage thicker than in preceding growth stage; growth rugae developed on disjunct whorls whereas they are absent on the preceding whorls; sculpture apparently absent.

Dimensions :		Ht	Wt	Wap	Wh
	P47532	17.3	6.1	2.8	6+
	P47533	11.6	4.2	—	3+

Location of Types : National Museum of Victoria. Holotype, P47532. Paratype, P47533. Geology Department, Australian National University, Canberra. Paratypes ANU 36854 and ANU 36855.

Type Locality : Chatterton's (1973, p. 140) locality B, in the lower half of the "*Receptaculites*" limestone about 400m east-southeast of the homestead on Bloomfield Property, Parish of Waroo, near Yass.

Distribution : Type locality.

Material : Holotype, three paratypes and two other specimens.

Discussion : *M. (Ostioma) bloomfieldia* can be distinguished from the Lilydale species by its higher spired shape, presence of a selenizone at the mid-whorl periphery rather than immediately below it, and its slightly large size. Both species have a noticeable construction of the shell at the junction of the inner and outer lips during the change from the ephebic to gerontic whorl shape.

Murchisonia (Ostioma) albanica sp. nov.

(Pl. 1, figs. 11, 12, 13)

Diagnosis : Moderately small, high spired pupiform gastropod with selenizone and disjunct moderately straight final growth stage; lacking spiral sculpture.

Description : Moderately small high spired pupiform gastropod with gently rounded whorls between impressed sutures; periphery at mid-whorl; nucleus unknown; base at ephebic stage well rounded; aperture at ephebic stage incompletely known; inner lip unknown; outer lip at ephebic stage with a broad shallow sinus that culminates in a shallow moderately concave slit which generates a selenizone immediately below the mid-whorl periphery; selenizone slightly elevated above whorl surface and bordered on each side by a narrow depression; with growth, slit in outer lip becomes shallower; ephebic outer lip countinues onto the gerontic disjunct whorl(s) for only a short distance; aperture of disjunct growth stage apparently circular; growth rugae developed on disjunct whorls whereas they are absent on the preceding whorls; sculpture absent except for collabral growth lines and rugae.

Dimensions :		Ht	Wt	Wh
	P28720	11.1	5.1	5+

Location of Types : National Museum of Victoria. Holotype, P28720.

Material : Holotype.

Discussion : This species is known from only one specimen. The ephebic stage can be distinguished from *M. (M.) bilineata*, the type species of *Murchisonia*, by its more pupiform shape, rounded whorl profile, raised selenizone below the mid-whorl periphery and absence of strong cords bordering the selenizone.

Family SUBULITIDAE Lindstrom, 1884.
Subfamily SUBULITINAE Lindstrom, 1884.
Genus SUBULITES Emmons, 1842.
Subgenus SUBULITES (Fusispira) Hall, 1872.

Type Species : *Fusispira ventricosa* Hall, 1872; Middle Ordovician; Trenton Limestone, De Pere, Wisconsin, U.S.A.

? Subulites (Fusispira) sp.

(Pl. 1, figs. 23, 24, 26, 27)

Description : Medium, fusiform gastropod lacking an umbilicus; whorl profile gently convexly arched to nearly flat between shallow impressed sutures; base extended; narrow ovoidal aperture extended adapically; columellar lip of moderate length, straight and moderately thick; parietal lip straight and of moderate length; parietal inductura if present thin; outer lip thin; presence or absence of an anterior notch unknown; sculpture apparently absent.

Dimensions :

	Ht	Wt	Hap	Wap	Wh
P1095	15.6*	8.7*	5.9	—	4*
P42051	22.6	13.8	10.3	11.7	7

Location of Types : National Museum of Victoria. Figured specimens P42051 and P1095.

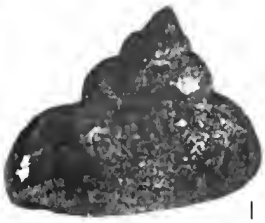
Material : Figured specimen and one other specimen.

Discussion : Assignment of these specimens to this subgenus is questionable because of their poor preservation. In each case there is a lack of a well preserved apertural region, an area of great diagnostic significance in the taxonomy of this family. Comparison between the type species *S. (F.) ventricosus* and the Lilydale form is limited by the poor preservation of both. The type species is much larger and has a narrower, more elongate aperture than the Lilydale form. While both forms have an aperture that is extended adapically, the aperture of the Lilydale form does not narrow adapically as rapidly.

Chapman (1913, p. 227) records *Macrocheilus* sp. from the Lilydale Limestone. This observation was based on a specimen in the National Museum of Victoria collection. Specimen P1095 is accompanied by a label written by Chapman and identifying it as *Macrocheilus*. This specimen is poorly preserved particularly in the apertural region. *Macrocheilus* is considered by Knight (1941) to be an objective synonym of *Macrochilina*. This genus is characterized by the presence of an externally visible siphonal notch, an internal siphonal canal and parietal folds. None of these diagnostic features are visible on this specimen. In particular, there is no evidence of parietal folds on either specimens. Thus although the ascription of these specimens to the subgenus *Subulites (Fusispira)* is questionable it is considered to be of greater validity than Chapman's assignment of specimen P1095 to the genus *Macrocheilus*.

PLATE 2

Figs. 1-2 *Australonema wellingtonensis* (Etheridge), F.2694, syntype, Wellington Caves, N.S.W., x1½.
Fig. 3 *Australonema wellingtonensis* (Etheridge), F.26956, syntype, Wellington Caves, N.S.W., x2.
Fig. 4 *Australonema lilydalensis* (Etheridge) F.1325, holotype, Lilydale, Victoria, x1 (approx.).
Fig. 5 *Australonema lilydalensis* (Etheridge), P44074, hypotype, Lilydale, Victoria, x2.
Fig. 6 *Australonema lilydalensis* (Etheridge), F.1325, holotype, Lilydale, Victoria, x1 (approx.).
Fig. 7 *Australonema australis* (Etheridge), F.1251, paratype, Lilydale, Victoria, x1.
Fig. 8 *Australonema australis* (Etheridge), F.1138, holotype, Lilydale, Victoria, x1
Fig. 9 *Australonema australis* (Etheridge), F.1251, paratype, Lilydale, Victoria, x1
Fig. 10 *Australonema* sp. indet. F.23449, Quidong, N.S.W., x1.
Fig. 11 *Australonema* sp. indet. F.23275, Quidong, N.S.W., x1 (approx.)
Fig. 12 ? *Australonema* sp. A, P44085, Symes Quarry, Killara, Victoria, x2.
Fig. 13 ? *Australonema* sp. B, F.27860, Bowning, N.S.W., x1½.
Figs. 14-15 *Australonema* sp. A, P40531, Dudley, Britain, x1 (approx.).
Figs. 16-17 *Australonema melbournensis* sp. nov., P44082, holotype, Lilydale, Victoria, x1 (approx.).



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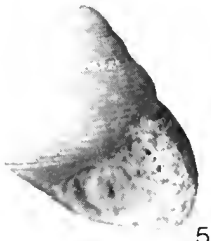

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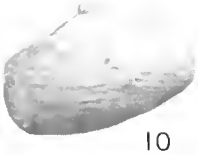

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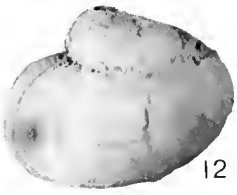

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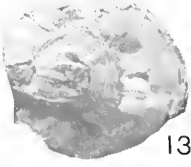

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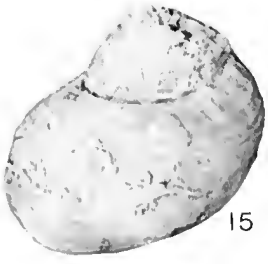

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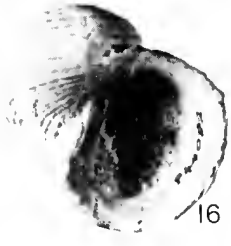

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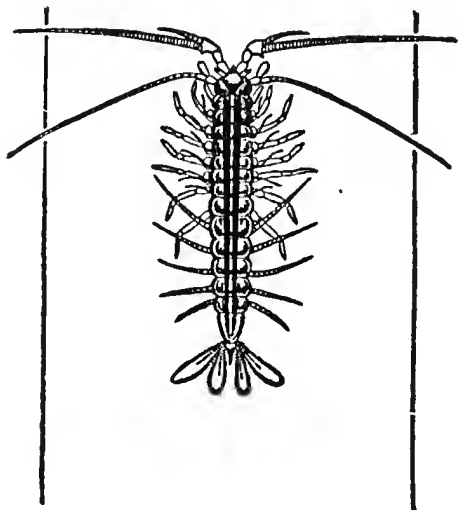
No. 70

RECORDS OF THE QUEEN VICTORIA MUSEUM LAUNCESTON



Edited by
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Director of the Museum

HUNTERS AND FARMERS IN THE HUNTER ISLANDS:

Aboriginal and European Land-use of north-west Tasmanian islands in the historical period

by

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INTRODUCTION

One of the consequences of the transition from a hunter-gatherer economy to a food-producing economy (i.e. agriculture, farming) is usually thought to be an increase in the number of people which a given area of land can and does support under the new economic regime. For instance, Bender (1975 p. 5) sees food-production as a 'combination of factors [which] eventually increased the carrying capacity of the land : the same amount of land could support more people'. She further comments that 'the trend of this argument is that innovation in the economic base allows increased population' (Bender 1975 p. 6). In this paper I want to describe a situation where the reverse situation occurred : an area of land which supported more hunters than it subsequently did farmers. If population is indeed a guide to adaptive success, then the hunters of Hunter Island were more successful than the farmers who came after them. A similar situation has been indicated by Rhys Jones (1971) for the west coast of Tasmania generally. The Hunter Islands can be seen as a geographical extension of the Tasmanian west coast, and their smaller area, well-defined by the fact that they *are* islands, allows for a more precise investigation of this phenomenon. A detailed scrutiny of the available documentary evidence, undertaken in the course of an archaeological investigation of Hunter Island, and considered in the light of that investigation, shows that Tasmanian Aboriginal use of the Hunter Islands in the recent prehistoric period was more systematic and wide-ranging than that of the agricultural Europeans in the historical period. While it is true for Tasmania generally that 'only a hundred and fifty years after the arrival of the Europeans the agriculturally based population is some fifty to a hundred times as great as that of the hunters' (Jones 1971 p. 284), this is not true of particular regions within Tasmania, including the Hunter Islands.

The Hunter Islands are a small archipelago lying just off the north-west tip of Tasmania (Figures 1 and 2). The largest, Three Hummock Island, is just 9300 ha in area; yet the recent history of the group, sketchily documented though it is, presents a microcosm of events in Bass Strait after the wreck of the *Sydney Cove:* navigators French and British; sealers with and without Tasmanian Aboriginal consorts; surveyors for the Van Diemen's Land Company; George Augustus Robinson; naturalists; muttonbirders; farmers. Unlike the larger and better-known Bass Strait Islands, however, most of the islands of the Hunter group were frequented by Tasmanian Aborigines in pre-European times.

EUROPEAN DISCOVERY

Tasmania was discovered by Tasman in 1642 and settled by the British in 1803. It was proven to be an island in 1798, and this date also conveniently marks the beginning of an economic interest in Tasmania and the Bass Strait Islands by Europeans, which began the conflicts with Tasmanian Aboriginals which led to the disruption of their traditional culture. The discovery and exploration of Tasmania by Europeans are well documented (e.g. West 1852) and will not be recounted here; likewise, the effect of this on the Aboriginal inhabitants of Tasmania has been recounted elsewhere (notably Ryan 1975). A discussion of the documentary history of the Bass Strait islands is presented here, especially that pertinent to the Hunter group, and of the implications that the historical accounts have for our understanding of the Aboriginal exploitation of these islands.

Whether Tasmania was joined to the Australian mainland or not was first speculated upon by Cook in the journal of his first voyage (in Beaglehole 1968 pp. 298-9). On his second voyage in the *Resolution,* he became separated from the second ship, the *Adventure,* near Kerguelen Island. The *Adventure,* commanded by Captain Tobias Furneaux, made for

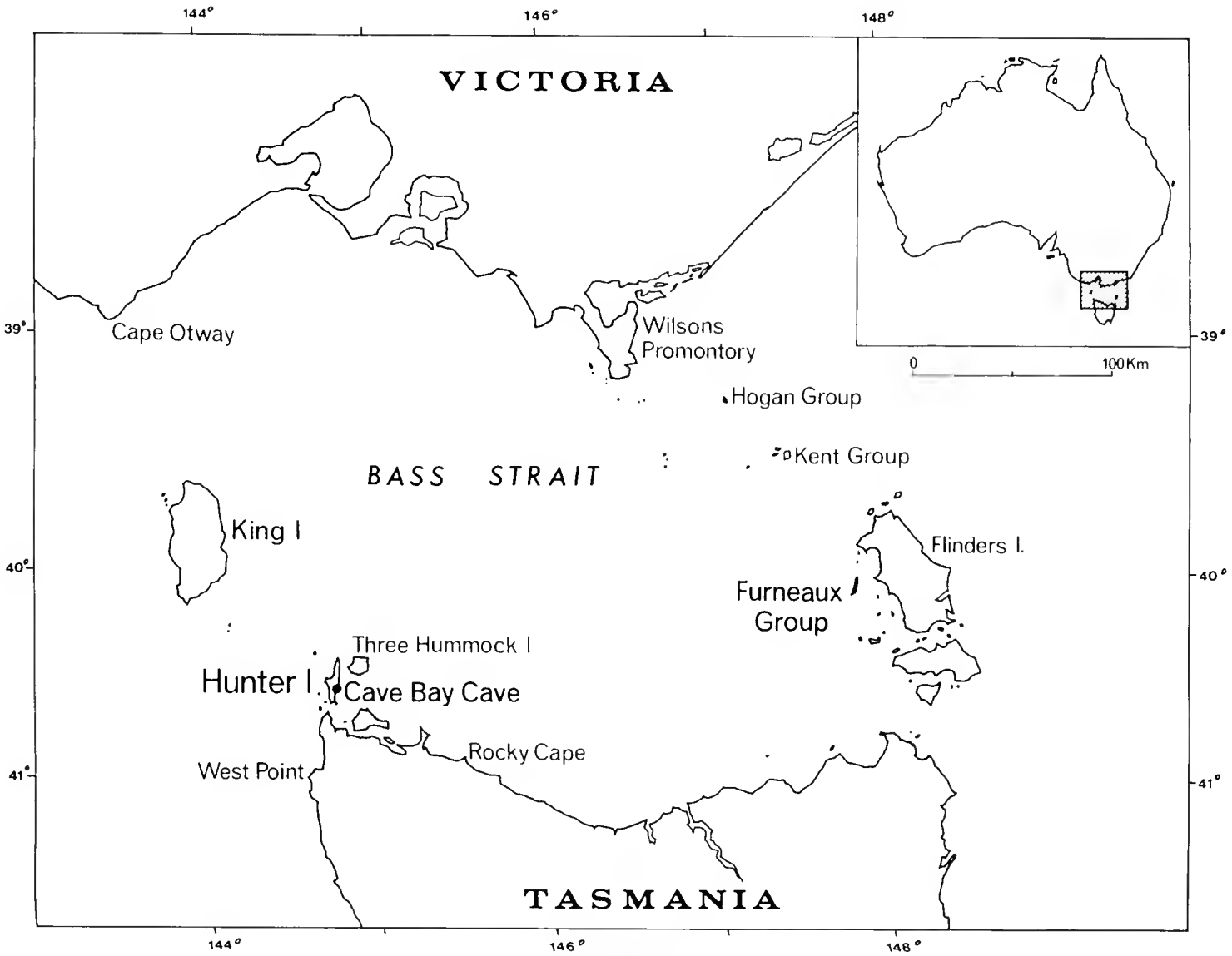

144°
146°
148°
VICTORIA
39°
Cape Otway
Wilsons
Promontory
Hogan Group
Kent Group
BASS STRAIT
King I
40°
Flinders I.
Furneaux
Group
Three Hummock I
Hunter I.
Cave Bay Cave
Rocky Cape
West Point
41°
TASMANIA
0
100Km

FIGURE 1

Adventure Bay on the east coast of Tasmania to take on wood and water before attempting to rendezvous with Cook. Furneaux then sailed north up the east coast, intending to solve the problem of 'whether Van Diemen's Land joins with New Holland'. He sighted and named Cape Barren Island, but instead of sailing west to put the matter to the test, he declared that in his opinion no strait existed and sailed east to rendezvous with Cook (Beaglehole 1969 p. 736). His second Lieutenant, James Burney, did not share his opinion : 'I think it not at all unlikely that there is a passage between New Holland and Van Diemen's Land' (in Hooper 1975 p. 43). Others on the *Adventure*, including the astronomer Bayly, shared Burney's, rather than Furneaux's, opinion (Hooper 1975 p. 43n). Furneaux's name however is commemorated by the largest group of islands in Bass Strait, which includes Cape Barren and Flinders Islands.

The problem was allowed to lapse until 1797, when the *Sydney Cove*, bound from Calcutta to the nine-year-old settlement at Port Jackson, run aground on Preservation Island, south of Cape Barren. Seventeen of the crew embarked for Port Jackson in a long-boat, which was itself wrecked near Cape Howe. Only three members of the party reached Botany Bay, where they were found by Europeans. Governor Hunter then sent the colonial schooner (the *Francis*) to the south to bring back any survivors. The commander of the *Sydney Cove*, Captain Guy Hamilton, the only European left with the ship, and the 'remainder of the Lascars' were thus removed to the unfortunate ship's namesake settlement (*HRNSW* III p. 277-8, 757 ff.). The wreck had two inter-connected consequences : one was the exploratory voyage of the *Norfolk* which demonstrated the existence of Bass Strait, the other was the concurrent voyage of the *Nautilus* which demonstrated the existence of the economic potential of Bass Strait, its seals.

In January 1798, George Bass sailed south from Port Jackson in a whaleboat. He rounded Wilson's Promontory and got as far as Western Port Bay, after which he had to turn back due to lack of provisions (*HRNSW* III p. 312-24; Flinders 1814 : cxi-cxiv). He was able to conclude that 'whenever it shall be decided that the opening between this and Van Diemen's Land is a strait, this rapidity of tide and that long S.W. swell that seems to be continually rolling in upon the coast to the westward, will then be accounted for' (*HRNSW* III p. 327). Governor Hunter was greatly impressed by Bass's enthusiasm and fortitude, no less because his conclusions paralleled Hunter's own conjectures on the matter (*HRNSW* III p. 363, 474). While Bass was still away in the whaleboat, Hunter dispatched the *Francis* on another trip to the wreck of the *Sydney Cove* on Preservation Island, to remove the rest of the crew and salvagable property; this time, the crew of the colonial schooner included Matthew Flinders (*HRNSW* III p. 363, 474). Flinders was included for the express purpose of making observations 'serviceable to geography and navigation'; among other discoveries, the Kent Group of islands was sighted and named (Flinders 1814 p. cxx ff.) Flinders' conclusions as to the existence of a strait confirmed those of Bass vis-à-vis the straightforward physical facts of tides and currents, but he was more perplexed by the human bio-geographical element :

> We stretched on until the land was seen beyond 40° 50'; and then veered to the northward. In this latitude, captain Furneaux says, "the land trenches away to the westward"; and as he traced the coast from the south end of the country to this part, there could no longer be a doubt that it was joined to the land discovered by Tasman in 1642. The smokes which had constantly been seen rising from it showed that there were inhabitants; and this, combined with the circumstances of there being none upon the islands, seemed to argue a junction of Van Diemen's Land with New South Wales; for it was difficult to suppose, that men should have reached the more distant land, and not have attained the islands immediately situated; nor was it admissable that, having reached them, they had perished for want of food. On the other hand, the great strength of the tides setting westward, past the islands, could only be caused by some exceedingly deep inlet, or by a passage through to the southern Indian Ocean. These contradictory circumstances were very embarrassing; and the schooner not being placed at my disposal, I was obliged, to my great regret, to leave this important geographical question undecided. Flinders 1814 pp. cxxxvi-cxxxvii).

In consequence of the reports of both Bass and Flinders, Hunter had the sloop *Norfolk* fitted out and sent her south under their joint command, to settle finally the question of the strait (*HRNSW* III p. 474).

The voyage of the *Norfolk* did indeed supply the wanted proof, as in it, Bass and Flinders circumnavigated Tasmania hence proving it an island; they also discovered the Hunter Islands. Three narratives of the journey are avaivable : that of Bass is recounted by Collins (1802); one of Flinders, perhaps reproduced direct from his journal, is to be found in the *Historical Records of New South Wales* (v. III); and there is Flinders' more

retrospective account (1814). There are also Flinders' more sketchy notes of 1801. In October 1798 the *Norfolk* left Port Jackson making for first the Kent group, then the Furneaux Islands, then Van Diemen's Land itself. The explorers spent some time in the north-east, including Port Dalrymple, the outlet for the River Tamar, within which lie some small islands. They had also explored Isle Waterhouse, two miles off the mainland in the north-east. Waterhouse and Green Islands, the latter in Port Dalrymple, were both found to be prolific of sea birds and their eggs, and Waterhouse of hair seal also. From this Flinders concluded that both islands were unfrequented by Aborigines, 'and that, consequently, they had no canoes upon this part of the coast' (Flinders 1814 pp. cl-cli). Of Green Island, Flinders considered he had '... corroborating proofs that the natives of this part of Van Diemen's Land have not the means of transporting themselves across the water; for Green Island is scarcely two cables length from the shore' (Flinders 1814 p. cliv). After leaving Port Dalrymple, the explorers sailed westwards along the north coast of Tasmania, sighting and naming Table Cape, Rocky Cape, Circular Head, and Three Hummock Island, then rounding Cape Grim and skirting round the west, south and east coasts to return to the vicinity of the Furneaux Islands, thence to Sydney.

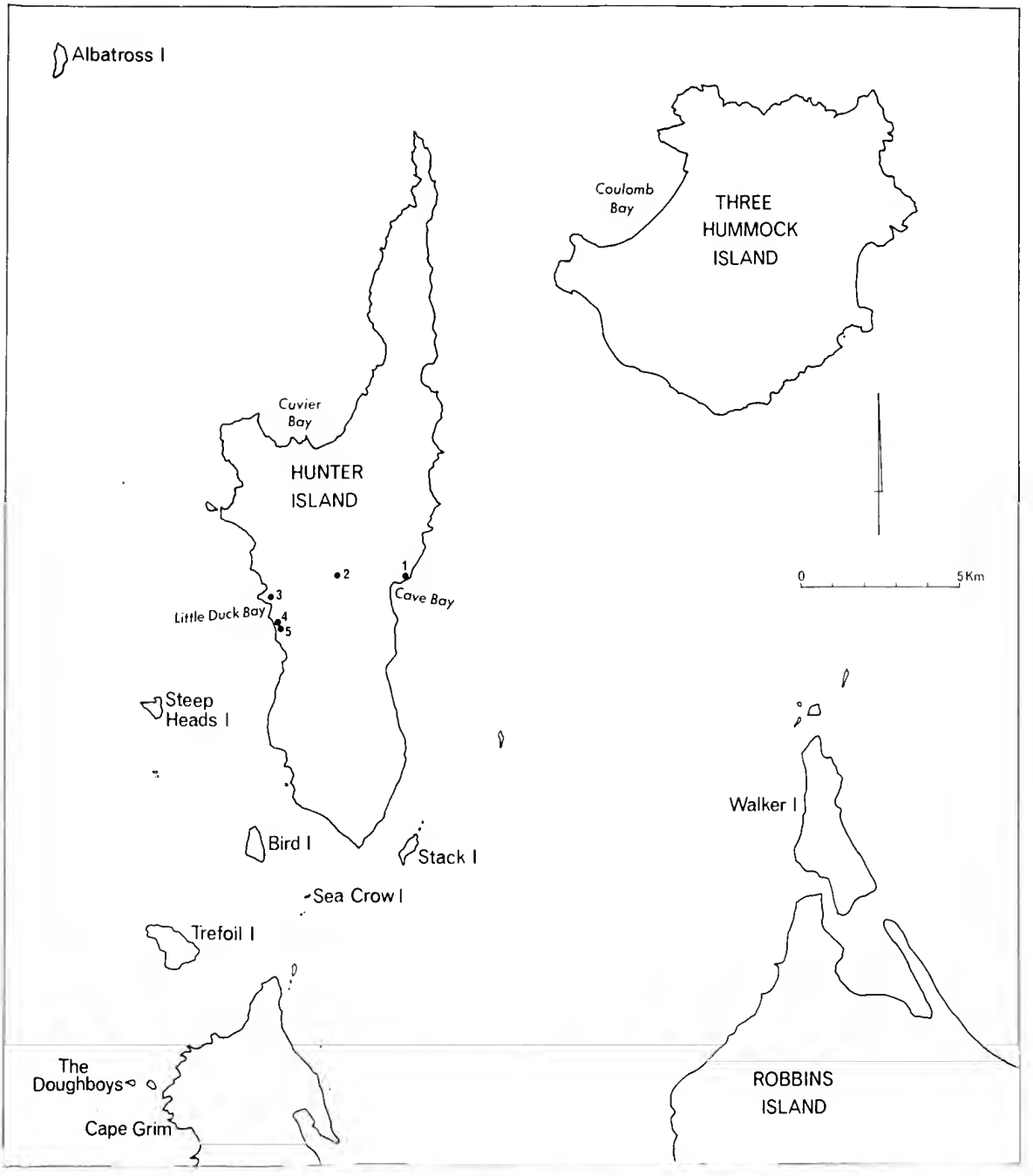
On the night of December 8th, 1798, the *Norfolk* had anchored off the north-east side of Three Hummock Island, without the men having realised that it was in fact an island. Bass went ashore, and met with 'frequent marks of natives' (Flinders in *HRNSW* III p. 796), 'several deserted fire places, strewed round with the shells of the sea ear' (Flinders 1814 p. clxx) and evidence of burning. In Flinders' retrospective account, he states that Bass 'found it impenetrable from the closeness of the tall brush wood, although it had been partially burnt not long before' (Flinders 1814 p. clxx); Collins' version of Bass' account however states that 'large patches [of the vegetation] appeared to have been burnt many months ago, but the small brush and creeping vines only were destroyed; the closeness of the blackened saplings was still irresistible' (Collins 1802, p. 171). In the morning, they were astonished to discover they had anchored off an island. Flinders' apparently earlier account runs as follows :

> Having satisfied ourselves that the land of the Three Hummocks was certainly divided from the land to the westward, and by a channel of 3 miles in width, a difficulty recurred which we could not solve — the natives had been upon it, and yet we were tolerably certain that at Port Dalrymple they had no canoes and by analogy, none here; but it did not appear probable that the island could be visited without. This is a dilemma which I am obliged to leave as I find it. (Flinders in *HRNSW* III p. 79).

In the 1814 account, Flinders paraphrased this, adding the comment that 'the small size of Three Hummock Island rendered the idea of fixed inhabitants inadmissable' (Flinders 1814 p. clxxi) — again showing his biogeographical appreciation. He also appends a footnote, to the effect that 'future visitants to these islands have seen the Indians passing over in bodies, by swimming . . .' (Flinders 1814 p. clxxi n.), perhaps a reference to Chace (see below). Flinders' persistent insistence on the lack of canoes is curious. He was right that they had none at Port Dalrymple — the Tasmanian Aborigines of the north-east and north coasts did indeed lack watercraft of any kind (Jones 1976 pp. 248-9). By 1814 however he should have been aware of the existence of a sort of canoe elsewhere in Tasmania, as they were described and figured by Labillardière, (who had accompanied D'Entrecasteaux to Tasmania in 1792), in his publication of 1800 (Labillardière 1800 I p. 230, II plate XLVI). Furthermore, it is possible that Flinders had been shown pictures of Tasmanian watercraft in 1802. On the 8th April of that year, the historic meeting took place between Flinders on the *Investigator* and Baudin commanding the *Géographe* and the *Naturaliste*. This happened at Encounter Bay on the coast of what is now South Australia; Baudin and his companions, including the anthropologist Peron, had recently spent some weeks on the east coast of Tasmania. Flinders went aboard the *Géographe* twice, accompanied both times only by the naturalist Robert Brown, because 'I did not understand French'; but the conversations 'were mostly carried on in English which the captain spoke so as to be understood' (Flinders 1814 pp. 189-90). Brown's surviving notes contain the following comments :

> Captain Baudin showed us coloured figures of the natives of Van Diemen's Land they appeared to be characteristic but not well executed. There were figures of their huts, of their tombs, and of their canoes. The canoe is exactly similar to that given by Billardière. (Giblin 1929 p. 4).

Besides Three Hummock Island, Flinders sighted and named the Black Pyramid, Steephead Island, Trefoil Island and Albatross Island (*HRNSW* III p. 797, Flinders, 1814 pp. clxxii-clxxiii). Bass went ashore on the last-named, and Flinders commented that the albatrosses 'being unacquainted with the power or disposition of man, did not fear him' (Flinders 1801



1. Cave Bay Cave 2. Stockyard Site 3. Little Duck Bay 4. Rookery Rockshelter 5. Muttonbird Midden

FIGURE 2

p. 29). He was initially unsure whether the land visible to the west of Three Hummock Island was part of the main or not, but on ascertaining that there was in fact a channel at its southernmost extremity named it Barren Island (Flinders 1814 p. clxxii), having commented that it is 'apparently as barren as Three Hummock Island, to which the vegetation bears a good deal of resemblance' (*HRNSW* III p. 797). The whole group he named Hunter's Isles, in honour of the man who had sponsored the expedition. Most of Flinders' names are still in use, with one notable exception : his Barren Island is now the group namesake, and is called Hunter Island.

EUROPEAN EXPLOITATION AND ABORIGINAL REACTION

The *Norfolk* did not sail from Sydney unaccompanied; Flinders recounts that 'my report of the seals at Furneaux's Islands had induced Messrs. Bishop and Simpson, the commander and supercargo of the snow[1] *Nautilus*, to prepare their vessel for a sealing speculation to that quarter; and on Oct. 7, we sailed out of Port Jackson together' (Flinders 1814 p. cxxxviii). Collins commented that the venture was 'tolerably successful' (1802 p. 137). It was certainly successful enough to precipitate not only an industry, but a way of life. The pattern established by Bishop became a familiar one. The *Nautilus* returned to Sydney in December 1798, having left 14 men on Cape Barren Island to continue hunting the seals. She returned to Cape Barren in January 1799, and stayed till March, when they had obtained some 9000 skins (Collins 1802 p. 137, Cumpston 1973 pp. 11-2). Thereafter, it was customary for groups of 10 to 15 sealers to be deposited on islands, from ships operating out of Sydney, from November till May (Ryan 1975 p. 64). Between 1800 and 1806 over 100,000 sealskins were thus obtained. Ryan (1975 p. 64) has estimated that 'by 1810, 300-400 [sealers] were in the area entering into reciprocal arrangements with Aborigines from the north coast of Tasmania'. By this time however, the seal population had declined considerably, and from then on was exploited almost exclusively by sealers resident in Bass Strait itself including the Hunter Islands; by 1814 only fifty sealers remained (Cumpston 1970 p. 50). It seems to have become customary by this time for resident sealers to be living with Aboriginal women, obtained from Tasmania initially by exchange, later by raiding. These women were acquired not only for sexual purposes, but also for their kangaroo hunting prowess, and their seal-catching ability which may or may not have been a traditional role; it is in fact unlikely that kangaroo hunting was such (Ryan 1975 p. 65; Plomley 1966 p. 1008; Robinson 28.4.32 p. 601;[2] Hiatt 1967 p. 206).

Clearly, the acquisition, forcible or otherwise, of women by sealers was a disruptive element in the life of Tasmanian Aborigines, particularly in the northerly parts of the island. But with the establishment of a British convict settlement at Risdon Cove on the Derwent in 1803, hostilities between Aborigines and Europeans intensified, and continued inexorably as the British spread out and expropriated the land.

Many sealers were attracted to western Bass Strait by the discovery of King Island in 1800. This, the largest island in Bass Strait, lies some hundred kilometres northwest of the Hunter group, and was first sighted and named by John Black of the *Harbinger* (Cumpston 1973 p. 41). English sealers followed. In September 1801, the snow *Harrington* made for King Island from Sydney with a sealing gang consisting of 'industrious seamen, settlers at Sydney', and returned in December with 3000 skins and 2500 gallons of seal oil (Cumpston 1973 p. 43). The *Harrington* returned to King Island under the command of William Campbell in March 1802; this was likewise primarily a sealing voyage, but some reconnaissance of King and the adjacent small islands was carried out. The wreck of an unknown vessel was found, but no trace of any survivors. The *Harrington* sailed for Sydney in May, leaving 13 men on King Island (Cumpston 1973 pp. 45-6; *HRA* 1. III p. 524).

Much of the King Island coastline was charted by John Murray commanding the discovery ship, *Lady Nelson*. On 25th January 1802, he anchored off Three Hummock Island. Murray sent a boat ashore with the first mate and two hands :

> ... by noon they returned having shot 2 ducks and found a spring of water, some small kangaroo were seen but not worth shooting even could they have been got at. The footsteps of a man were seen on shore, perhaps one of the Harrington's Lascars as the foot was measured and found very small. (Lee 1915 pp. 124-5).

1. Snow : 'small brig-like sailing vessel with supplementary trysail mast' (C.O.D.) A snow is a brig with the fore-mentioned supplementary mast (J. S. Cumpston, personal communication).

2. References to the journals of George Augustus Robinson give first the date (in this case 28.4.32 = 28th April, 1832), then the page number as it is found in Plomley's (1966) edition.

As there is no record of the *Harrington* having got as far south as the Hunters, it is possible that the footprints seen by the *Lady Nelson*'s mate were in fact those of a Tasmanian Aboriginal.

In December 1802 the French expedition led by Baudin spent some three weeks in western Bass Strait, mostly in the vicinity of King Island. Their encounters with English sealers, notably a gang led by one Daniel Cooper, resulted in Peron's well-known description of their operations (Peron and Freycinet 1816). The French navigators also encountered Charles Robbins commanding, on this occasion, the *Cumberland*; he had been despatched from Port Jackson expressly to forestall any possibility of French settlement (*HRA* 1, III pp. 737-9). Baudin's response could be described as ironic (Baudin 1974 p. 446). On the 7th December, Baudin sent off the Sydney-built schooner *Casuarina* under Freycinet's command to survey the Hunter Islands (Baudin 1974 p. 439). The main legacy of this is numerous French place names still in use : Cape Keraudren, Cuvier Bay, Cape Renaud on Hunter Island; Cape Rochon and Coulomb Bay on Three Hummock Island; and Hunter Island itself was for a time known as Fleurieu Island.

The earliest surviving eyewitness account of Tasmanian Aborigines on any of the Hunter Islands seems to be that of a sealer, J. Chace. The following report appeared in the *Sydney Gazette* of May 15, 1803 (vol. I. no. 11) :

> Yesterday evening arrived the Good Intent, Mr. J. Chace Master, from Bass's Straits, with 2500 skins, great part of which were procured at King's Island, whence he departed towards the end of March.
>
> From Mr. Chace's report . . .
>
> 'We afterwards overhauled Hunter's Islands, in search of seals, and found those islands, 12 or 13 in number, well peopled with natives who bear a strong resemblance, in manners and appearance, to those of this colony: they appeared to be much terrified at our approach, and having no canoes, swam from one island to another with surprising facility, against a very strong current.
> 'Hunter's Island on the East side contains a very fine and spacious bay, sheltered from the winds at N. by W., to SSE abundantly supplied with water, as it also is with wood'.

This last is possibly Cave Bay.

Before 1804, Three Hummock and Hunter Islands were the only large islands of the group known. Flinders had been able to make out only a 'great bight' to the south of Three Hummock Island, hidden in haze. In December of 1804, Charles Robbins, on a rather more genuinely exploratory mission than that of the *Cumberland*, carried out a detailed survey of the Hunter Islands. Unfortunately, his journal and chart are missing (Lee 1927 p. 106). His sketch of the Hunters does however survive, and was used by Flinders to compile his 1814 chart (Flinders 1814, I p. clxix, and atlas). Robbins identified the island named after him by Flinders, the similarly eponymous passage which separates that island from the Tasmanian main, and Perkins Bay to the west of Circular Head. He appears to have carried out some land exploration of Robbins Island, which is low-lying, swampy and accessible on foot from Tasmania at low tide. He also went ashore on the west side of Three Hummock Island (Lee 1927 pp. 104-7).

In 1805 or 1806, John Oxley, then a naval lieutenant, sailed the schooner *Estremina* to Port Dalrymple (*HRA* 3, I pp. 735-6, 744). In his subsequent report of 1810, he includes the following comments on the Hunter Islands, although it is not clear whether he visited any of the islands himself :

> An assemblage of barren rocks, totally destitute of fresh water or wood, the solid rock which forms them being covered with heath and brush; they are separated from the main by a narrow channel dry at low water, and are now and then frequented by the wandering native in search of the precarious subsistence the shell fish on their shores may afford. (*HRA* 3, I p. 774).

It will be noticed that this assessment is rather harsher than those of other observers.

James Kelly was a first generation Australian who began his sailing career at the age of 13, in 1804. His first command was the schooner *Brothers*, in which he embarked on a sealing voyage to Bass Strait in 1812-13 (Bowden 1964 pp. 15-6). February and April were spent off Three Hummock and Hunter Islands, catching seals from 'The Rock'; was this Neils Rock, off the southern tip of Three Hummock Island? Late in 1815, Kelly began his celebrated circumnavigation of Tasmania in a small whaleboat. The journey took the opposite direction to that of Bass and Flinders in the *Norfolk*, being clockwise around the

island. After sailing up the west coast, and discovering Port Davey and Macquarie Harbour, the party in the whaleboat rounded Cape Grim on the morning of the 4th January 1816, 'pulled along the shore to the eastward until we came to the south end of the largest Hunter's Island. We landed on the point opposite to the mainland on a large plot of pebble stones' (Kelly in Bowden 1964 p. 30). This description clearly indicates that Hunter Island itself is meant, though Robbins Island is larger (cf. Bateson 1973 p. 39). Kelly's account is important, as he encountered Aborigines here, who had got there by their own devices; I will therefore give it at some length.

> There were a great many fires along the shore, and we kept the boat and arms ready in case of an attack from the natives. ...We had just lighted a fire, when we perceived a large body of natives, at least 50 in number, standing on the edge of the bush about 50 yards from us. They were all armed with spears and waddies. We immediately brought the arms from the boat, and put ourselves in a state of defence. [Both parties eventually lay down their arms]. The natives then began to come to us, one by one, holding up their hands to show they had no weapon but we kept a good look-out that they had no spears between their toes, as on a former occasion. They had none. They were twenty two came to the fire. We made signs to them that no more should be allowed to come. Upon that being understood, two others came from the bush together. One of them seemed to be a chief, a stout good-looking man about six feet high, and apparently thirty years of age; the other an old man, about six feet seven inches high, with scarcely a bit of flesh on his bones.

The 'chief' ordered the old man to sing and dance and distract the Englishmen, while the Aborigines gathered together stones 'about the size of hen's eggs'. The former became worried, and produced a couple of swans, which the latter attempted to take by force; when unsuccessful, they threw the stones at Kelly's party. Kelly then fired amongst them, frightening the old man so he fell down in a faint. The Englishmen set him on his feet, and he retreated. 'As soon as he was lost to our view, the hills around echoed with shouts of joy from the voices of men, women and children'. Some marks of blood were found on the stones in the direction the Aborigines had fled, and Kelly supposed that some were wounded.

> We then got into our boats. Just as we were pulling away we received a large volley of stones and spears from the natives. One spear went through the side of the boat, but luckily no one was hurt. We landed on a small rock, covered with birds. They were laying, and we got six bucketfulls of eggs — a good supply. This seemed to offend the natives, as a number of women came down on a point of rocks and abused us very much for taking their eggs. (Kelly in Bowden 1964 pp. 30-2).

Not everyone feels that Kelly's account should be taken as a perfectly accurate record (e.g. Plomley 1966 p. 39 n. 36); his 'six feet seven inches gentleman', for instance, seems a little unlikely (cf. Roth 1899 p. 9), but Robinson describes WYMURRICK, of Robbins Island, as being 'a very fine man upwards of 6ft 6 ins.' (23.6.32 p. 622). Lack of confidence in Kelly's report seems to arise mainly because different accounts of the whaleboat voyage are available, written by Kelly himself at different times, and also by others (Bowden 1964 pp. 23, 106). These accounts do not however differ with respect to the points discussed here. If we accept the narrative at face value, we can glean the following facts. Kelly stated initially that he saw 'at least 50' natives 'all armed with spears and waddies' — hence presumably all men. Of these, 24 came to the Englishmen's fire. After the retreat of the tall old man, Kelly referred to the voices of 'men, women and children' — fact, or rhetoric? The small rock may have been one of the Henderson islets, the birds may have been muttonbirds, particularly given the quantities suggested. It is not clear just where the women were, on the Tasmanian mainland or Hunter Island, though the latter seems indicated . Ryan (1975 p. 195) has suggested that their abuse in this case was due to Kelly violating an arrangement by taking the eggs without payment.

The Aborigines' skirmish with Kelly and his party was relatively trivial, compared with confrontations taking place elsewhere (Turnbull 1948 p. 51; Ryan 1975 p. 79), and the situation deteriorated thereafter. In the north-west, the establishment of the Van Diemen's Land Company exacerbated the conflict. The company was formed by English speculators, who applied for 500,000 acres of land, mainly with the intention of running sheep for wool. The company was formed in 1825; its agent in Tasmania was Edward Curr, who set up his headquarters at Circular Head in 1826. The company was said to have actually received 350,000 acres in separate blocks : 150,000 acres at Woolnorth; 20,000 at Circular Head; 10,000 at the Hampshire Hills; 10,000 at the Middlesex Plains; 150,000 at the Surrey Hills; and 10,000 at the islands on the coast. (West 1852, I pp. 111-2). The islands acquired by the company, on a freehold basis, were Robbins and Trefoil in the Hunter group — Robbins alone being at least twice 10,000 acres, in fact. Hunter, Walker and Robbins Islands had

apparently been visited by Adey on behalf of the company in 1826 (Meston 1958, map). The ill-fated Henry Hellyer had visited both Robbins and Hunter Islands at some time and Curr examined Trefoil Island in 1829 (Meston 1958 p. 29). The acquisition of all this land for pastoral purposes had a disruptive economic effect on the Aborigines, as the open land most desirable for depasturing sheep was also important for hunters, both for game and passage across the land (Ryan 1975 p. 197). There were other consequences, leading to direct and bloody clashes. Many sealers were employed as boatmen and shepherds, and many shepherds wished to acquire Aboriginal women (Ryan 1975 p. 197). Shortly after the company began to run sheep on the Woolnorth 'property', some Aborigines from the west coast came to Cape Grim in the course of their seasonal round, in November 1827. Company shepherds managed to lure some women into their huts and 'wanted to take liberties with them'; their men companions objected, and speared one of the shepherds in the thigh. The aboriginals retaliated further by driving a mob of sheep over a cliff and killing them. Four of the shepherds waited their chance : a group ('tribe' according to Robinson) of Aborigines, mostly women and children, came to the Doughboys, six weeks after the sheep killing incident, for muttonbirds. The shepherds set upon them, massacred thirty and threw them over the same cliff. The locale then acquired the name of 'Victory Hill' (Robinson 16.6.1830 p. 175; 21.6.30 pp. 181-2; 24.6.30 pp. 182-3, 231n. 103; 10.8.30 p. 196).

Such incidents accelerated everywhere the Europeans settled, and the Aborigines, like the shepherds, began to make more random and savage reprisals. By 1828, Governor Arthur was driven to extremes. On the one hand, he declared martial law and initiated the 'Black Line'; on the other he hired George Augustus Robinson to 'conciliate' the Aborigines. The Black Line was a failure in terms of its avowed purpose of capturing Aborigines, although it is seen to have had other, not totally undesirable effects. It appeased the settlers, encouraged public spending during a period of recession, and drove many Aborigines to less settled areas (Ryan 1975 pp. 113-5).

ROBINSON IN THE HUNTER ISLANDS

George Augustus Robinson was an English-born artisan who had answered an advertisement of Arthur's for 'a steady person of good character, who can be well recommended, who will take an interest in effecting an intercourse with this unfortunate race, and reside upon Brune Island, taking charge of the provisions supplied for the use of the natives of that place' (Plomley 1966 p. 51). He got the job, and spent most of 1829 on Bruny Island. He then suggested to Arthur his plan for peaceful conciliation : he, Robinson, would go off into the bush and persuade the Aborigines to come in. Arthur was not initially greatly impressed, but after the failure of the Line, and Robinson's first success, he granted him official support. Robinson spent much of the next four years in the bush, persuading what Aborigines remained to return with him to the benefits of civilization. If this led to their demise, it was perhaps a more peaceful one than may otherwise by this stage have been the case. Robinson's solution to the 'black war' was in some ways a final one, but compared with many of his contemporaries, he was an enlightened man.

Robinson first visited the Hunter Islands in June 1830. One of the problems he saw as most important and difficult to overcome was that of the Aboriginal women who cohabited with European sealers (Ryan 1975 p. 300). After spending a few days at Woolnorth with the congenial Joseph Fossey, Robinson set off by boat to visit some sealers thought to be resident on Hunter Island (referred to by him as the West Hunter). He was presumably accompanied by those eastern Tasmanians who had travelled with him from Hobart; Dray, who was a native of the south-west, seems to have stayed with relatives or tribespeople in that region (Robinson 30.1.30 p. 97; Plomley 1966 p. 241). After landing on the east side of Hunter Island (perhaps at TID.DE.BEEN.HER), he crossed to the west side of the island where the sealers had their huts, but presumably found them unoccupied at the time, as he comments that 'the sealers had gone to the main to hunt kangaroo' (18.6.30 p. 176). As no-one else appears to have been there, it is not clear how he knew this, along with much other information he says he was given by the sealers, none of whom he actually met till two days later. It is possible he wrote some of this up later than the actual dated entries, but perhaps also he was accompanied by 'ex-sealers' now working for the Van Diemen's Land Company. Some information he may have acquired on this, as on other occasions, from Alexander McKay. McKay was a ticket-of-leave man in Robinson's escort party who had previously been coxswain for the Van Diemen's Land Company since its establishment in north-west Tasmania (Robinson 20.6.30 p. 180; 5.8.30 p. 192; 27.9.30 p. 220). The party re-crossed the island to where they had left the boat, and pulled off to the south east, through the Petrels and down the east side of Walker Island (which Robinson called Mosquito Island), where they landed and camped the night. In the morning, Robinson and 'three of the natives' walked across to the west side of Walker, and his journal at this point offers further information of an historical kind : 'The island at one time abounded

with kangaroo, but like the other islands they have been destroyed by the sealer's dogs. This was a resort for the natives and from here they would go to Petrel Island to get birds.' (Robinson 19.6.30 p. 178). Again, it is unclear where he is getting this information. On the same day, he walked across Robbins Island, 'accompanied by WOORRADY and the two Aboriginal females' (presumably TRUGERNANNA and PAGERLY, all three from the east coast) and commented 'here the natives procure their shells for beads' (Robinson 19.6.30 p. 178). Later on he stated 'there is a tribe of natives that belongs to this island . . . and from this island they could go to others, to the rocks to get birds, fish &c, and to the main' (Robinson 19.6.30 p. 178). There is nothing in this information that contradicts what we know from other sources and other information given by Robinson, and it is possibly attributable to late writing up, as on other occasions (Robinson 14.4.30 p. 150; Plomley 1966 pp. 229 n. 69, 70).

On the 20th June, 1830, Robinson and his party came to the sealers' other camp, across the channel on the Tasmanian main. This time, most were in residence; four male sealers, six Aboriginal women and one Tasmanian Aboriginal man. The leader of the sealers was a New Zealand Maori called John Witleye, who had two of the women; an Englishman Robert Drew (also known as Rue) also had two women; there was another Englishman called David Kelly, and a 'half-caste youth', Edward Hanson (Tomlin). Robinson remarks in parentheses that two other men were at Launceston (one was Starker, soon after drowned; 9.12.30 p. 295). Of the women, one is described as 'a native of this part and the other five were eastern women . . . one is sister to PAR.WARE.TAR', who was travelling with Robinson's party. The Aboriginal man was TUNNERMINNERWAIT, a native of Robbins Island. He had been with the sealers only seven days prior to Robinson's advent and seems to have needed little persuasion to join up with Robinson's mission; he accompanied him on all his Tasmanian missions thereafter. Had he known this would lead to his being the first person hanged in Victoria he might not have been so keen (Robinson 20.6.30 p. 179-8; Ellis 1976 p. 96). He was however a most useful informant for the Cape Grim-Hunter Islands region.

Robinson stayed a couple of days with the sealers, gathering information from them and the women, the latter supplying some details of the Victory Hill massacre. The site was visited by Robinson a couple of days later, and it seems clear on this occasion that the details of the massacre, and other comments on Trefoil and Bird Islands, were supplied by McKay (Robinson 21.6.30 p. 181; 24.6.30 pp. 182-3). After spending a few days more at Cape Grim, Robinson set off for Robbins Island, on which a smoke was seen. He proceeded inland on foot with TUNNERMINNERWAIT, and thus acquired 'two fresh natives' : in fact, one was TUNNERMINNERWAIT's brother, PENDOWTEWER, the other a woman from West Point (Robinson 1.7.30 p. 184). On their way back to Cape Grim, the party called at the sealers' camp to discover that the New Zealander and the women had been deposited on Hunter Island for the day, or perhaps the man was to be picked up again but the women left for a longer period (Robinson 1.7.30 p. 184). Four days later, Robinson returned to Robbins Island and was told the sealers had left, and had burnt their windbreak. The next day, their women left also, to Robinson's regret (5-6.7.30 p. 185). Shortly thereafter the party set off for Circular Head.

There is much of ethnographic and historical interest arising from Robinson's first brief visit to the Hunter Islands, but clearly some of it should be treated with at least a little caution. McKay's information is often, if not always, second-hand, as in his account of the sealers' raid for women near the Doughboys some years earlier. Robinson was proffered three separate accounts of this incident (if all refer to the same event) : that of McKay, that of TUNNERMINNERWAIT, and that of PENDEROIN (a brother — classificatory? — of TUNNERMINNERWAIT). The two Aborigines both said they were present at the time, TUNNERMINNERWAIT as a child, but McKay said he had 'heard some of the men that was there relate the circumstance'. TUNNERMINNERWAIT's account, which includes the names of five of the abducted women, clearly owes something to having heard the story retold. It is however striking how much more similar McKay's and TUNNERMINNERWAIT's versions are to each other than either is to PENDEROIN's, perhaps indeed suggesting that two very similar but separate events happened at about the same place (Robinson 1.7.30 p. 185; 20.8.30 p. 202; 21.8.30 pp. 203-4; 20.2.34 pp. 845-6; cf. Ryan 1975 p. 196). Robinson's information arising from this visit then comes into a number of categories : his own observations, such as the sealers' activities and relationships with the women; second-hand, 'informant' information, such as TUNNERMINNERWAIT's general ethnographic comments; and third-hand accounts, such as McKay's, which surely come into the category of 'gossip' (cf. Hiatt 1967 p. 109). There are also the times mentioned above when it is quite unclear from whom Robinson is getting his information.

Robinson returned to the north-west in 1832. He intended to try and round up such Aborigines as remained at large on the west coast; he was also concerned about the final

location of the Aboriginal establishment, and Hunter Island seemed a possibility. He arrived at Cape Grim early in June, and set off south down the west coast. On this occasion he was accompanied by his usual group including two local Aborigines, TUNNERMINNERWAIT, whom he had recruited from the sealers on Robbins Island two years before, and NOL.LER.HAL.LA.KER or NOLLERALLEKE, also known as Kit. This woman was a native of Cape Grim, had been taken by sealers (apparently including Dobson and Kelly) from Robbins Island when a girl and had been living with Robert Drew until removed by James Parish (on Robinson's behalf) in December 1830 (Robinson 20.12.30 p. 297; 19.6.32 p. 618). She was very likely the 'native of this part' who had been living with the sealers at Robbins Passage.

Robinson spent a month on the West Coast between Cape Grim, Bluff Hill Point and the upper reaches of the Welcome River. By using TUNNERMINNERWAIT and Kit as decoys, or at least, go-betweens, he recruited 23 Aborigines by peaceful means. These included two of TUNNERMINNERWAIT's brothers, WY.MUR.RICK, described as a chief, and PEN.NE.MOON or PENDEROIN. As well as Robbins Island, the people were from West Point, the Arthur River, Sandy Cape and one, included in the group by marriage, from Macquarie Harbour (Robinson 15.7.32 p. 630, 17.7.32 p. 633; Plomley 1966 pp. 701-2). After returning to Cape Grim, Robinson determined to shift his entire party to Hunter Island, as he feared the new acquisitions would otherwise abscond (Robinson 21.7.32 p. 634). To effect the move, he made use of the sealers; on this visit, indeed, he made much use of the sealers all round. Their livelihood had clearly declined in the two years since Robinson was here last. There were now only four men, all apparently English; Robert Drew and David Kelly whom Robinson had met previously, John Dobson and another unnamed young man. Kelly was cohabiting with two women said to be the same ones as previously; Drew was living with two women; Dobson was living with the woman BUL.RER, who had been on Kangaroo Island. Also with them was an old woman, 'Old Betty', who had come from King Island. They now had their base camp on Stack Island (Robinson 4.6.32 p. 612; 11.6.32 p. 613; 22.7.32 p. 635; 13.9.32 p. 657). After persuading all his party into the boats, Robinson and the sealers ferried them to the latters' camp on Stack, then to the east side of Hunter Island. MANNALARGENNA, his wife and an unnamed white man had been despatched to Hunter Island the previous day to establish a camp. The whole party now made an encampment at a place called TID.DEE.BEEN.HER probably somewhere along the modern Ainslie Beach (Robinson 22.7.32 p. 635).

Robinson's informants during this sojourn are more obviously reliable than on the earlier occasion; not only was he accompanied throughout by Kit and TUNNERMINNERWAIT, but the people recruited on the west coast were clearly familiar with the islands. About two weeks after landing on the island, the camp was shifted to the west side, possibly the exact spot where the sealers had their encampment two years ago. Robinson recounted that

> The Aborigines call this place NUM.DID.DE.MO.HE.DOPE.HER, and the encampment on the east side of the island TID.DE.BEEN.HER. The elderly natives know this place well and have names for all parts of this and the other islands. They crossed over from Cape Grim to Trefoil, thence to an island midway between Trefoil and the Hunter, and thence to the Hunter; crossed over in catamarans. (Robinson 13.8.32 p. 641).

The proximity of Hunter Island to the main, and the obvious ease of Aboriginal passage between the two, did not suit Robinson's plans for an Aboriginal 'colony' on the Island.

Near the end of August, Robinson made another foray down the west coast. He recruited only four new women on this excursion, and at the Arthur River lost one of his previous recruits, and almost his life, to a group of some 31 Aborigines who chose to decline the benefits of civilization on this occasion. He returned to Hunter Island. The situation there was somewhat uneasy; quarrels and rumours were rife, with nothing very specific eventuating, apart from a rather pathetic attempt on the part of Kit to join up with the sealers (Robinson 16.10.32 p. 669). It had occurred to Robinson that Three Hummock Island, known to him as the East Hunter, might be a rather more failsafe prison than Hunter itself. To that end, he made a visit to the further isle, accompanied by RACKERDUNNUPE, a Sandy Cape woman. She and LARRATONG, the wife of the Robbins Island chief WYMURRICK, had told Robinson that 'they have been to all parts of the East Hunter, that there is plenty of grass at the north end, and seal and mutton birds on the rocks, and wallaby, also large fern tree' (Robinson 14.10.32 p. 669). He had also been told by the pilot Parish that the latter had been on the island 'for a long time and caught abundance of wallaby' (Robinson 19.10.32 p. 671). The prospect of Three Hummock as a utopian prison was rather spoilt however by RACKERDUNUPE : '...she had been there and knew the place well. This woman told us the story of her swimming across the passage from one

island to the other thinking it would amuse me, but it had a contrary tendency and pointed out the insecurity of the place for keeping the natives upon. This story she told me several times, and now whilst we were crossing' (Robinson 19.10.32 p. 672). She may have been no fool. The camp had shifted to DRAY.WOON.NER, or Shepherd's Bay, on the north-east of Hunter Island, with an eye to shifting it again to Three Hummock; but by now, Robinson had relinquished the idea of a permanent establishment on any of the Hunters. Shortly after his visit to Three Hummock Island, he left the Island and set off for Hobart. The Aborigines remained on the island, encamped again on the west side of the island under the charge of Anthony Cottrell. Cottrell was to rendezvous with Robinson at Macquarie Harbour; he set off with the Aborigines, and recruited seven more on the way, whom he despatched to Launceston. In the course of 1833 and 1834 Robinson rounded up most of the Aborigines remaining at large on the west coast. As is well known, the permanent Aboriginal colony was established on Flinders Island, and here ended up nearly all those Aborigines who had helped Robinson and/or been recruited to his missions. Their demiso is equally well-known.

Less well known, and in some ways less tragic, is the fate of many of the sealers' women. Ironically, or so it would have seemed to Robinson, these 'poor creatures' did what the Establishment Aborigines failed to do : perpetuated themselves. The offspring of sealers and Aboriginal women formed the basis of a viable community in the eastern Bass Strait islands which survives to this day, whose members are usually referred to as 'Cape Barren Islanders'.

The subsequent history of the sealers and Aboriginal women in the Hunter Islands is somewhat unclear. BUL.RER was turned over to Robinson by Drew (Rue) in 1832 (Robinson 17.8.32 p. 642). At about the same time 'Old Betty' died on Stack Island (13.9.32 p. 657), and the same year, Lieutenant Darling removed Kelly's two women 'with their consent' (30.10.32 p. 676). Of the group encountered by Robinson, this would have left only Drew's two women. Of the men, Dobson was living in Launceston by 1837 (Plomley 1966 p. 1012) and Kelly had removed to Preservation Island in the eastern straits in the same year (Plomley 1966 p. 1013). The group must have drawn reinforcements from elsewhere however, going by the following account by Stokes of his visit to the Hunter Islands in 1838 :

> On Walker Island our boats met the wives of some sealers whose husbands had gone to King Island on a sealing excursion. They were clothed like those on New Year Island. One was half European and half Tasmanian, and by no means ill-looking; she spoke very good English and appeared to take more care of her person than her two companions who were Aborigines of pure blood. A few wild flowers were tastefully entwined with her hair, which was dressed with some pretensions to elegance. They had a pack of dogs along with them and depended in a great measure for their maintenance on the wallaby they killed. The skin also of these animals constitutes to them an important article of trade. (Stokes 1846 I pp. 272-3).

In 1847, Robert Rew (Drew) crops up on Cape Barren Island, and on Hunter Island in the same year a man named William Proctor lived with a part-Aboriginal Tasmanian woman and two of their children (Ryan 1977 p. 36). This could have been the same family group encountered by a party of field naturalists in 1861, mentioned by Plomley : 'They first visited Hunter Island, where they found a man, his wife and three children living, the only inhabitants of these western islands'. Plomley suggests the family was probably that of David Howie, but other sources suggest that Howie lived on Robbins Island, and in fact was probably dead by this time (Plomley 1971 p. 19; Smith 1970 p. 170; Horner 1974 pp. 54-5; Pauline Buckby personal communication; Lyndall Ryan *in litt.*).

ABORIGINAL LAND-USE IN THE ETHNOGRAPHIC PRESENT

Ethnographic information which may be derived from the historical accounts is as follows. We need to distinguish Robbins Island from the other islands of the group, because it was the most easily accessible; hardly indeed to be considered an island at all. We know from Robinson that there was a band which was based on Robbins Island (27.7.30 pp. 190-1; 4.4.31 pp. 335; 9.4.31 pp. 339; 17.7.32 p. 633; 31.12.32 p. 705; 7.4.34 p. 874). He also refers to 'the Robbins Island dialect'. (1.4.30 p. 185). The other islands of the group, and the mainland, were visited by members of the Robbins Island band (Robinson : 16.6.30 pp. 178-9). The islands were also visited by members of most of the west coast bands, from as far as Sandy Cape 100 km to the south (Robinson 14.10.32 pp. 668-9). It seems that groups of up to 50 people may have visited the larger islands, including men, women and children (Kelly in Bowden 1964 pp. 30-2; Robinson 14.10.32 pp. 668-9).

The islands visited included Hunter, Trefoil, Three Hummock, Walker and one of the Petrels. While there are accounts of Aborigines swimming between islands (e.g. Chace

above), Meston (1936 p. 157) regards it as an 'impossibility' that people should swim from the mainland to the islands, because of the tides and currents. It is likely therefore that the initial trip from the mainland was by catamaran, but on occasions, people swam from one island to another (Robinson 19.10.32 p. 672). The trip to Hunter Island was made in stages, from Cape Grim, to Trefoil, to an island between Trefoil and Hunter, thence to Hunter (Robinson 13.8.32 p. 641).

The question of seasonality is difficult, as it usually is. There seems no question of permanent habitation of any of the islands except perhaps Robbins; and it seems that visits were of quite short duration (Robinson 20.10.32 p. 672). The early observations all suggest the presence of people during December and January (Flinders 1814 p. clxx; Murray in Lee 1915 p. 124-5; Kelly in Bowden 1964 pp. 30-2), except that of Chace who saw people swimming between the islands at the end of March (*Sydney Gazette* May 15, 1803). The times of year implied coincide with the availability of muttonbird eggs and chicks.

According to Meston (1936 p. 156), 'it was however not the abundance of wallaby, possum, crayfish and shell-fish that induced the aborigines to visit the islands, but the mutton-bird rookeries'. This would appear to be the meaning of Robinson, when, trying to convince the Aborigines they should live permanently on the islands, he comments 'there is no inducement; the birds are not in' (18.7.32 p. 633). He continues 'I enquired of the TYREELORE woman when the time was for the mutton birds to come in and they shewed me the lightwood tree that was near them and said that when that tree was in blossom the mutton birds would be in'. It is perhaps necessary to point out that TYREELORE (TY.REE.LORE, etc.) means 'aborigines from the islands' but elsewhere is used by Robinson only in connection with women living with sealers, mostly on the Furneaux Islands (25.10.30 p. 256; 9.11.30 p. 268; 12.11.30 p. 272; 25.12.30 p. 300; 26.12.30 p. 301). Jones (1974 p. 333) interprets this as implying that the islands 'were not often visited, if at all, during the winter months when the birds were absent'. Other resources are however mentioned by Robinson as equally important: seal, wallaby, shellfish and crayfish (14.10.32 pp. 668-9; 19.10.32 p. 671).

ABORIGINAL LAND-USE IN THE RECENT PREHISTORIC PAST

Some amplification of Aboriginal land-use of the Hunter Islands can be obtained from the findings of the archaeological project carried out on Hunter Island itself. For more detailed accounts of this project and its results, the reader is referred to Bowdler 1974a, 1974b, 1975, 1977, 1979 and Hope 1978. A site survey of the Island was carried out, and five sites were excavated: three open shell middens, a rock-shelter and a stranded sea cave. This last, Cave Bay Cave, contained a twenty-three thousand year old, but discontinuous, sequence of human occupation. Major geographical and climatic changes took place during that period, and here we are only concerned with the last few thousand years, or late Holocene part, of this sequence. Six thousand years ago, the sea reached its present level in Australia after a retreat concomitant with the last worldwide glacial event, which was also represented in Tasmania by extensive glaciation of the highlands and a lowering of the treeline. It is within the last six thousand years that Aboriginal exploitation of the island Tasmania as we know it today is evident in the archaeological record, particularly in the form of extensive shell middens around the modern coastline.

Substantial shell middens on several of the Hunter Islands provide evidence of Aboriginal presence in the recent prehistoric past. As well as Hunter Island, middens have been recorded on Three Hummock, Stack, Penguin, Sea Crow and Trefoil Islands (Bowdler 1974a). On Hunter Island itself, middens of varying size were sufficiently widespread and abundant to permit the assumption that all parts of the island were visited by Tasmanian Aborigines. The evidence of the excavated sites gives us some idea of how long the island had been being exploited.

Within Cave Bay Cave, midden deposits dated to between c.6600 and 4000 years old indicate an earlier exploitation of the region when it may or may not have been an island (Bowdler 1979 p. 339). There is then a hiatus in the sequence (archaeologically speaking), with resumption of human occupation indicated by more midden deposits dated to between 2500 and 900 years ago; there is no doubt that this represents exploitation of the island *qua* island. This latter part of the sequence overlaps with that of some of the open midden sites, and in general we may infer continuous exploitation of the island beginning about 2500 years ago, and continuing up until the ethnographic present.

The artefactual and faunal remains present in the midden sites and the uppermost archaeological deposits in the cave imply activities requiring the presence of both men and women. The large numbers of shellfish of which indeed the middens are primarily composed attest the presence of women regularly and systematically exploiting this resource (Bowdler 1979 pp. 188-223, 301-335; cf. Hiatt 1967, Bowdler 1976). The presence of children is confirmed by the recovery of a deciduous human incisor from the Little Duck Bay midden (Bowdler 1979 p. 335).

More tenuous is the evidence for the number of people resident on the island, or present at any one time. Jones (1971 p. 278) discusses the ethnographic evidence for substantial huts on the west coast, and the likelihood that these are represented archaeologically by circular depressions in the large shell middens found here (see also Jones 1947 and Lourandos 1968). This has recently been confirmed for one site by Don Ranson (personal communication). Jones (1971 p. 278) further points out that such huts contained anything from about six to twelve people. On Hunter Island, I have located five such depressions, two on the Little Duck Bay site, two on a large similar midden near the lighthouse at Cuvier Bay, and one on a smaller midden on the west coast of the island between Cuvier Bay and Little Duck Bay (fig. 2). Others have been reported to me by the lessee. Let us assume however that there are at least five such depressions which were used contemporaneously. This would imply between 30 and 60 people present on the island at a time. The Little Duck Bay midden however, or at least the one hut site excavated is radiocarbon dated to between c.1000 and 900 years ago (Bowdler 1979 p. 309); the other depression at this site may be older or younger as indeed may be the other depressions on both sites. What these depressions do imply is the presence of at least one hearth group at a time who stayed long enough to need a substantial hut; and the Little Duck Bay dates further reinforce the notion that systematic Aboriginal exploitation of the island has a long history measurable in centuries.

It was assumed by Flinders (and others) that the Hunter Islands were too small to support permanent year-round occupation. This is not archaeologically demonstrable one way or the other at the present time, although fieldwork (carried out in the summer of 1979/80) is designed to shed further light on questions of seasonality of occupation. Some connection with the Tasmanian mainland however is definitely indicated by the presence in the midden sites of stone artefact raw materials foreign to the island, particularly west coast spongolite (Bowdler 1979 pp. 306, 313, 321).

In general, the archaeological data confirms the general picture obtained from the ethnohistorical records, and adds to it by providing a time depth. It is evidence that the Aboriginal exploitation of the Hunter Islands seen in the ethnographic present is the continuation of a systematic and complex system evolved over the previous two and a half millenia.

EUROPEAN LAND-USE AFTER THE SEALERS

Little information is available for the later part of the nineteenth century, but sometime between the 1860's and the 1890's Hunter and Three Hummock Islands began to be occupied by farmers, although there has never, to this day, been more than one household group (consisting of no more than two families) at one time on either island. The group was visited in 1889 by naturalist E. D. Atkinson (1890), who mentions a Captain John Burgess living on Three Hummock Island, and renting it from the Tasmanian government. (All Bass Strait Islands, except those in the original Van Diemen's Land Company grant, i.e. Robbins, Trefoil and Walker, are crown land and may not be owned freehold. They are available for long term lease only). Naturalists Ashworth and Le Souef (1895), who visited the group five years after Atkinson, also mention J. Burgess's farm on Three Hummock Island. Maps of the islands held by the Lands Department in Hobart however show the first recorded lessees of Three Hummock Island to have been three individuals named Irvine, Warne and Warne, from 1889. In 1904, the lease was taken over by Arthur Francis Grevis James. The present incumbents of Three Hummock Island discovered under the steps of the farmhouse a hand-written document, as follows :

Hummock Island
June 3rd, 1911

This is the names of the people living on the island at the time this house was built.

Mr. J. Middleton	Contractor	48 years
Edmund Burgess	Caretaker	55 years
Frances Burgess	Cook	— —
Benjamin Burgess	Cowboy	17 years
Irene Burgess	Milkmaid	15 years
Mr. T. Collins	Stonemason	53 years
Mr. H. Brain	Painter	34 years
Florence Brain		29 years
Harry Brain junr.		16 years
Reg Brain		6 years
Eric Brain		3 years

Written by Winnie Burgess aged 20 Milkmaid
F. Grevis James Esq., Proprictor (Ha Ha)
also Bill the lamb (Alliston 1966 p. 95)

J. Burgess is recorded as having occupational licences for Bird and Stack Islands in 1897, R. Burgess was the lessee of Stack Island in 1897, and the lease of Three Hummock Island was taken over by J. and R. Burgess in 1921. Frank Grevis James is also on record as having the lease of Hunter Island in 1895. Mr. Maurice Sampson of Smithton remembers that a Burgess had a garden on Stack Island at the turn of the century (personal communication, 1975). There was clearly a whole family of Burgesses exploiting the Hunter Islands at this time; it is not clear, although it is likely, that they were connected with the Burgesses in the Islands of the eastern strait. It is clear however from the above document that cattle were being run on Three Hummock Island by 1911.

Grevis James may also have introduced cattle to Hunter Island. The lease for the latter was taken over by William Wilbraham Ford in 1909, before which he was obliged to clear off 'wild cattle'.[3] When he took over the lease, Ford was running 150 cattle, had 3698 acres under pasture in the centre of the island and 700 acres of paddock including a shipping paddock at Shepherd's Bay.[4] Cattle have been run on both Islands from at least the turn of the century until the present day, but with fluctuating fortune. The lease of Hunter Island was taken over by Bessie Isabel Busby in 1923, and it seems sho and her family were in residence there till at least 1945. There may have been a hiatus in occupation; Alliston (1966) reports Hunter Island as unoccupied in about 1950. The present lessee, P. J. Maguire, took over the island in 1953 or 1954, and has run beef cattle on it since.

CONCLUSIONS

Modern European land-use of the Hunter Islands has obviously been far from intensive. In 1911, Three Hummock Island had a population of 13 souls, and this figure has since decreased; a Scottish island of comparable size would have supported something like 1000 persons in the eighteenth century (Renfrew 1976 pp. 148-9). Hunter Island has not had more than one family group resident at a time since the days of the sealers; yet Kelly encountered fifty Aborigines there. While it is probably that Aboriginal visits were of short duration, Aboriginal use of these islands involved more individuals than did recent European use, and involved greater areas of island land also. This in some ways amplifies Jones' (1971) findings, that while the European population of Tasmania quickly and massively exceeded that of the prehistoric Aboriginal population, some parts of Tasmania became almost entirely depopulated : '... in Tasmania the farmers decided that every hunter had to be removed from the face of the earth to make way for the new order' (Jones 1971 p. 284). If population is indeed a guide to adaptive success, here on Hunter Island we have a rare instance of hunters proper (the Tasmanian Aborigines), being more successful than hunters tied into a monetary economy (the sealers), who in their turn were more successful than farmers. It is still in a sense hunters who reap the bounty of the islands : the mutton-birders (Ryan 1975 pp. 299-300, Smith 1970 p. 173, Gaughwin 1978). If it be argued that modern European land use is but a component of a far wider economic system, so indeed was the Aboriginal land use of these islands. Jones has discussed in several places (e.g.

3. Report by District Assessor J. L. Waters, 1st April 1909; Lands Dept. Correspondence 1193S/234-15, Tasmanian State Archives.
4. Report by District Assessor J. L. Waters, 12th January 1909, Lands Dept. Correspondence 1193S/111-115, Tasmanian State Archives.

1977 pp. 345-7) the notion of a 'regionally co-ordinated economic system' in north-west Tasmania, into which the Hunter Islands were incorporated two and a half thousand years ago. Kelly's account of the people he encountered on Hunter Island in 1816 gives us a last glimpse of the system in operation; shortly after this it was violently dislocated (e.g. the incident at Woolnorth in about 1827) and ultimately destroyed by the incursion of the newer, but perhaps in this case less efficient, system.

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